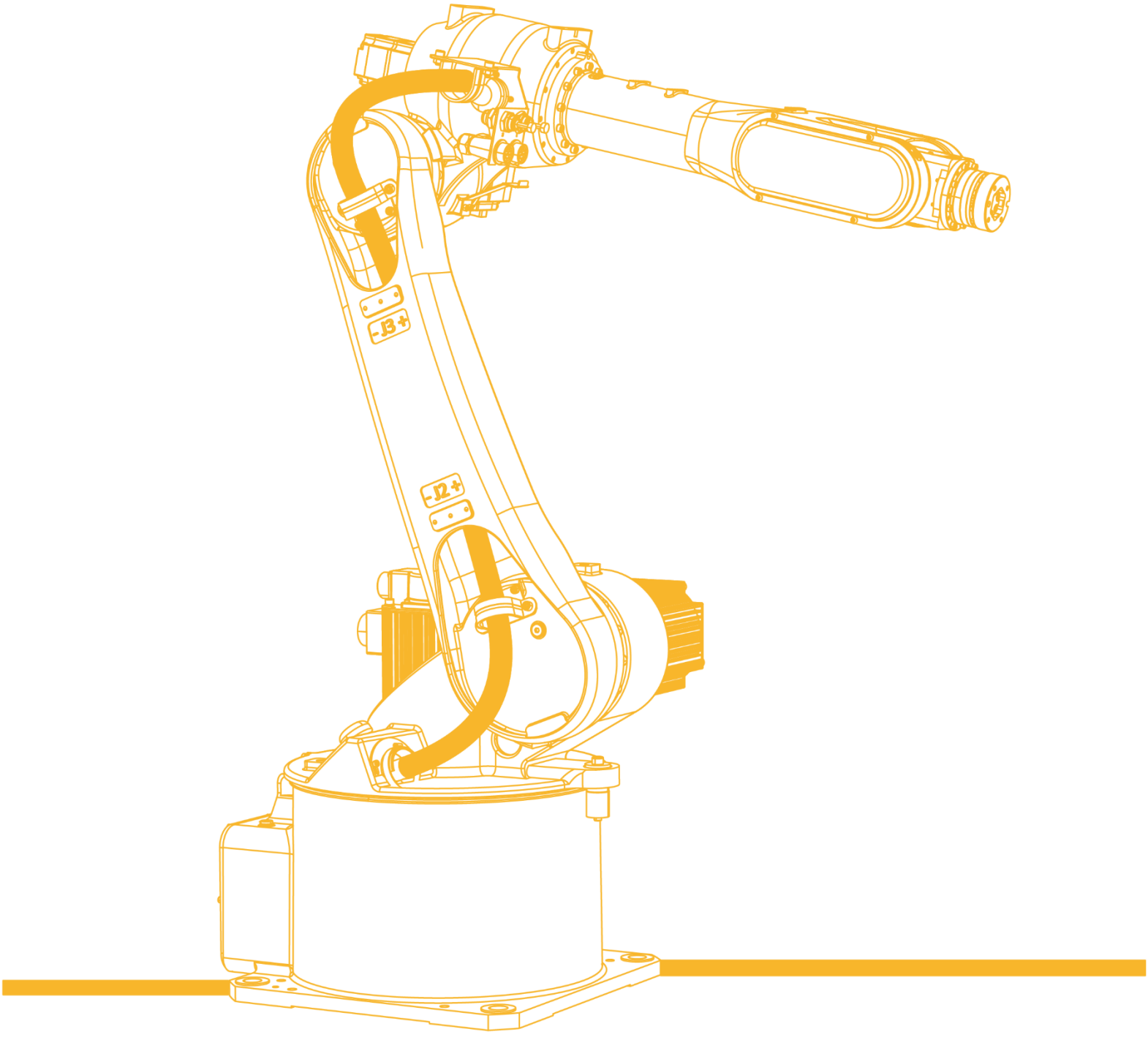
PEITIAN ROBOTICS

AIR12-1420 Operation Manual

V1.0.0



Foreword

About this manual

This manual is for technicians to install and use the AIR12-1420 industrial robot quickly, correctly, and safely, to be familiar with the relevant precautions, and to perform regular routine maintenance work on the manipulator.

Prerequisites

Before operating the robot, be sure to read the relevant safety instructions and operation instructions of the product carefully. Users must understand the safety knowledge and basic operation knowledge before using the robot.

Please read the following documents when necessary:

- "inCube20 Control Cabinet Manual"
- "AIR-TP teach pendant operation manual"
- "ARL Programming Manual"

Target groups

- Operators
- Product technicians
- Technical service personnel
- Robot teachers

Meaning of common signs

The signs and their meanings in this manual are detailed in Table 1.

Table 1 Signs used in this manual

Sign	Meaning
 Danger	Failure to follow the instructions may result in an accident causing the severe or fatal injury or the great losses of property.
 Warning	Failure to follow the instructions may result in an accident causing the severe or fatal injury or the great losses of property.

Sign	Meaning
 Caution	Prompt for the environmental conditions and important things or shortcuts you shall pay attention to
 Prompt	Prompt for additional literature and instructions for additional information or more detailed operating instructions

Manual description

The contents of this manual are subject to supplementation and modification. Please visit "Download Center" on the website regularly to obtain the latest version of this manual in a timely manner.

Website URL: http://robot.peitian.com/

Revision history

The revision history contains the instructions for each document update. The latest version of the document contains updates to all previous versions of the document.

Table 2 Signs used in this manual

Version	Publication date	Modification description
V1.0.0	2023.10.11	1st official release

Manual Number and Version

The manual-related information is shown in Table 3.

Table 3 Document-related information

Document name	"AIR12-1420 Operation Manual"
Document number	BJM/SS-UG-02-021
Document version	V1.0.0

Declaration of applicable with product standards

The requirements for industrial robot system design are detailed in Table 4.

Table 4 Declaration of applicable safety standards

Standard	Description	Version
2006/42/EC	Machinery directive: Machinery directive 2006/42/EC (new version) issued by European Parliament and Council on May 17, 2006 to modify 95/16/EC	2006
2014/30/EU	Electromagnetic compatibility directive: 2014/30/EU directive issued by European Parliament and Council on February 26, 2014 to balance the electromagnetic compatibility regulations of member states	2014
2014/68/EU	Pressure facility directive: Electromagnetic compatibility directive: 2014/68/EU directive issued by European Parliament and Council on May 15, 2014 to balance the pressure facility regulations of member states (It is only suitable for the robot with hydraulic balance weight)	2014
ISO 13850	Safety of machinery: Emergency stop function - Principles for design	2015
ISO 13849-1	Safety of machinery: Safety-related parts of control systems - Part 1: General principles for design	2015
ISO 12100	Safety of machinery: General principles for design - Risk assessment and risk reduction	2010
ISO 10218-1	Robots and robotic devices - Safety requirements for industrial robots : Part 1: Robots (Prompt: Information is consistent with ANSI/RIAR.15.06-2012, Part 1)	2011
61000-6-2	Electromagnetic compatibility (EMC): Part 6-2: Generic standards - Immunity for industrial environments	2005
61000-6-4 + A1	Electromagnetic compatibility (EMC): Part 6-4: Generic standards - Emission standard for industrial environments	2011
60204-1 + A1	Safety of machinery: Electrical equipment of machines - Part 1: General requirements	2009
IEC 60529	IP rating provided by enclosures (IP Code): This standard applies to the IP rating for the electrical equipment with enclosures and the rated voltage exceeding 72.5kv.	2001

General safety description

Thank you for purchasing our manipulator. This description is required for the safe use of the manipulator. before using the operator, please read the manual carefully and use the manipulator correctly on the premise of understanding it.

For the detailed functions of the manipulator, please fully understand its specifications through the relevant instructions.

Safety considerations

In general, the manipulator cannot be operated by a single operation, and only install the end effector, and the frame functions as the peripheral equipment and the system to perform the operation.

When considering its security, the manipulator should not be considered independently, but should be considered in the system environment.

When using the manipulator, be sure to take corresponding measures to the safety fence.

WARNING, CAUTION AND PROMPTS.

This specification includes matters needing attention to ensure the personal safety of operators and prevent damage to operators. According to their safety importance, they are described as "warning" and "caution" in this paper, and the supplementary instructions are described as "prompts".

Before using the operator, the user must read these "warnings "," cautions" and "prompts ".

 Warning	In the case of an incorrect operation, it is possible to cause death or serious injury to the operator or other operator.
 Caution	If the operation is wrong, it may cause the operator or other operator to slightly injure or damage the equipment.

General considerations


Warning

- When connecting or disconnecting related peripheral devices (such as safety fences, etc.) and various signals of the manipulator, be sure to confirm that the manipulator is in a stopped state to avoid incorrect connections.
- Do not use the operator in the situation shown below. Otherwise, it will not only have a negative impact on operators and peripherals, but also cause casualties.
  - Used in flammable environments.
  - Used in explosive environments.

- Used in environments where there is a lot of radiation.
- Used in water or in high humidity environments.
- Used for the purpose of transporting people or animals.
- Use as a foot (e.g., on or depending on the operator)

■ Operators who use the operator should wear the safety appliances shown below before carrying out their work.

- Work clothes suitable for the job content
- Safety shoes
- Safety helmet


Prompt

Personnel who carry out programming and maintenance operations must receive appropriate training through the relevant training of the company.

Considerations during installation


Warning

■ When handling and installing the machines, they must be carried out correctly according to the method shown in our manual. If the operation is carried out in the wrong way, it is possible that the operator will be killed or injured due to the overturning of the operator.

■ When using the operator for the first time after installation, be sure to do so at a low speed, and then gradually accelerate the speed and confirm that there are any anomalies.

Matters needing attention in operation


Warning

■ When using the operator, be sure to make sure there are no personnel in the safety fence before carrying out the operation. At the same time, check to see if there is a potential danger, and when it is confirmed that there is a potential danger, be sure to eliminate the danger before carrying out the operation.

■ When using the instruction device, because there may be errors in the operation of wearing gloves, it is important to take off the gloves before carrying out the work.


Prompt

Information such as programs and system variables can be stored in storage media such as memory cards. In order to prevent data loss caused by unexpected accidents, it is recommended that users back up data regularly.

Considerations in programming


Warning

When programming, try to do it outside the safety fence, the following matters shall be taken into account when the safety fence needs to be carried out as a last resort:

■ Check the safety fence carefully and make sure it is not dangerous before entering the fence.

■ The emergency stop button can be pressed at any time.

■ The manipulator shall be operated at low speed

	■ The operation should be carried out after confirming the state of the whole system, so as to avoid the operator falling into a dangerous situation due to the remote control instructions or actions for the peripheral equipment.
 Caution	After the program is finished, it is important to perform the test operation in accordance with the specified procedure. At this time, the operator must operate outside the safety fence.
 Prompt	For operators who are programmed, it is important to receive appropriate training through the company.

Attention should be paid to maintenance work


Warning

- When switching on the power supply, part of the maintenance operation is in danger of electric shock, as far as possible, the maintenance operation should be carried out in the state of power off; professional maintenance personnel should be designated according to the need to carry out maintenance operation; other personnel should be avoided to turn on the power supply when maintaining the operation; even if the power supply must be turned on before the operation can be carried out, the emergency stop button should be pressed and then the operation should be carried out.
- Please consult our company when you need to replace the parts.
- The replacement of parts by the client may result in unexpected accidents, which may cause the operator to be damaged and the operator is injured.
- When entering the security fence, check the whole system carefully and make sure it is not dangerous. If there is a dangerous situation and have to enter the fence, you must grasp the state of the system and be very careful.
- If you need to replace the parts, be sure to use our specified parts. If you use a part other than the specified part, it may cause damage to the operator.
- When removing the motor and brake, the crane hoisting and other measures should be taken to remove the motor and brake, so as to avoid the falling of the manipulator arm.
- When carrying out maintenance operations, when it is necessary to move the operator as a last resort, the following matters should be taken into account:
  - It is important to ensure that the escape channel is smooth and that the operation should be carried out again under the operation of the whole system in order to avoid blockage of the retreat by the operator and peripherals.
  - Always pay attention to the danger around you and be prepared so that you can press the emergency stop button at any time when you need it.
- The auxiliary equipment such as the crane shall be used when the moving motor and the speed reducer and the like have certain weight parts, so as to avoid the excessive work load for the operators. At the same time, it is necessary to avoid the wrong operation, otherwise, the operation and death of the operation may be caused.
- Be careful not to fall because of the lubricating oil that falls on the ground, wipe the lubricating oil that falls on the ground as soon as possible, and eliminate the possible danger.
- Do not place any part of the body on any part of the manipulator during the operation, and it is prohibited to climb on the manipulator , so as to avoid unnecessary personal injury or adverse effect on the manipulator .
- The following parts will be hot and need attention. When you have to touch the equipment when you have to touch it in the event of heat, you should prepare protective appliances such as heat-resistant gloves:
  - Servo motor

- reducer
- Adjacent to motor / reducer
- Inside the control cabinet

- The parts (such as screws, etc.) removed during the replacement of the parts should be correctly loaded back to their original parts, and if the parts are found to be insufficient or surplus, they should be reconfirmed and installed correctly.
- During the maintenance of the pneumatic system and hydraulic system, it is important to release the internal pressure to zero and operate again.
- After replacing the parts, be sure to carry on the test operation according to the prescribed method. At this point, the operator must operate outside the safety fence.
- After the maintenance operation, the grease, debris and water sprinkled on the ground around the operator and inside the safety fence should be thoroughly cleaned.
- When replacing parts, dust and other foreign bodies should be prevented from entering the manipulator.
- Operators who carry out maintenance and repair operations must receive the training of the company and pass the relevant assessment.
- When carrying out maintenance operations, appropriate lighting appliances should be equipped, but care should be taken not to make the lighting appliances a source of new danger.
- Be sure to refer to this specification for regular maintenance, if not regular maintenance, will affect the service life of the operator, and may lead to accidents.

Safety protection measures before use

Before operating the manipulator and peripheral equipment and the manipulator system composed of them, the safety precautions of the operators and the system must be fully studied. Figure 1 is a schematic diagram of the safe work of industrial robots.

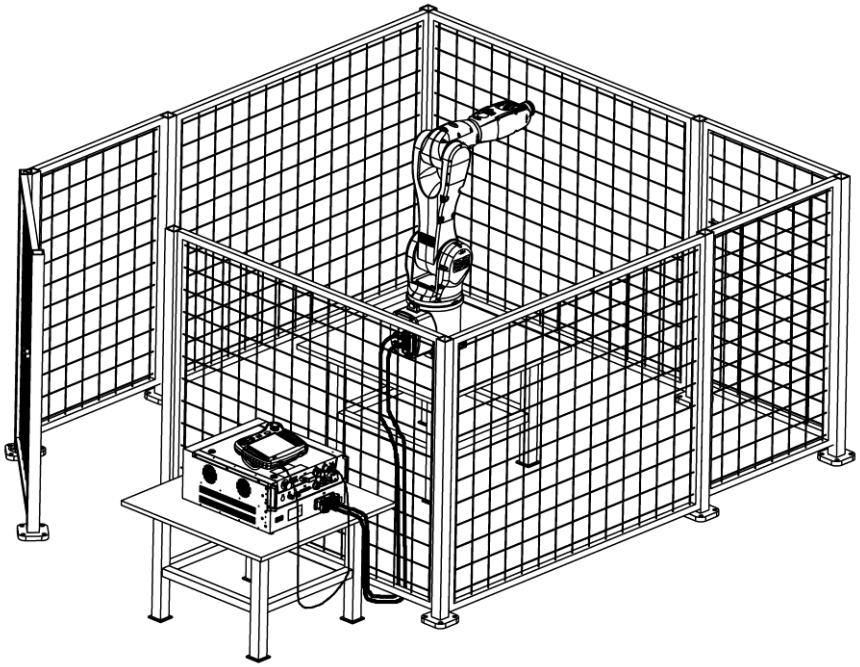


Figure 1 Schematic diagram of safe work of industrial robots

Definition of operating personnel

Manipulator operation personnel consist of operator, teacher and maintenance engineer who shall satisfy the following conditions:

Operator

- Switch on/off the power supply of manipulator.
- Start the manipulator program via the operating panel.
- have no right to operate within the safety barrier

Teacher

- Execute the functions of operator.
- Perform the manipulator teaching, etc. outside the safety barrier.

Maintenance Engineer

- Execute the functions of teacher.
- Perform the maintenance (repair, adjustment, replacement, etc.) of manipulator.

Safety of operation personnel

Operator, teacher and maintenance engineer shall carefully perform the operation, programming and maintenance of manipulator, and shall at least wear the following items:

- Work clothes suitable for task
- Safety shoe
- Helmet

When the auto system is used, be sure to protect the operation personnel. The measures shall be taken to prevent the operation personnel from entering the range of manipulator.

The general precautions are listed below. Please take the appropriate measures to ensure the safety of operation personnel:

- The operation personnel running the manipulator system shall receive the training from the company and pass the relevant assessment.
- While the equipment is running, even if the manipulator seems to have stopped, the manipulator is possibly waiting for the start signal and is about to act. The manipulator shall be regarded as operating at this state. To ensure the safety of operation personnel, it is necessary to confirm that the manipulator is in the operating state via the audible and visual alarms such as the warning lamp
- Be sure to set the safety barrier and safety door around the system so that the operation personnel cannot enter the safety barrier without opening the safety door. The interlock switch, safety pin, etc. shall be set on the safety door so that when the operator opens the safety door, the manipulator will stop.
- Peripheral equipment shall be electrically grounded.
- The peripheral equipment shall be set outside the range of manipulator if possible.
- The range of manipulator shall be clearly marked with the lines on the floor to make the operator understand the range of manipulator including the mechanical arm and other tools.
- A proximity switch or photoelectric switch shall be installed on the floor so that when the operation personnel are about to enter the range of manipulator, the audible and visual alarms such as the buzzer are issued to stop the manipulator, thereby ensuring the safety of operation personnel.
- A lock shall be set to make sure that the manipulator power cannot be turned on except by the operation personnel responsible for the operation.
- Always disconnect the manipulator power when performing the individual commissioning of peripheral equipment.

Safety of operators

Operators are not authorized to perform jobs within the safety barrier:

- Disconnect the power supply of manipulator control cabinet or press the emergency stop button when the manipulator is not operated.

- Operate the manipulator system outside the safety barrier.
- The guard fence and safety door shall be provided to prevent the unrelated personnel from entering the range of manipulator or to prevent operators from entering a hazardous location.
- Emergency stop button shall be set within the reach of operators.


Prompt

Manipulator controller is designed to be connected to an external emergency stop button. With this connection, the manipulator will stop when the external emergency stop button is pressed.

Safety of teachers

In some cases, it is necessary to enter the scope of operation of the operator when carrying out the operation of the operator, especially at this time, the safety should be paid attention to:

- If you do not need to enter the operation maneuvering range, be sure to operate outside the operating maneuvering range.
- Before proceeding with the teaching, verify that the manipulator or peripheral equipment is in a safe state.
- If it is inevitable to enter the range of manipulator to conduct the teaching, first confirm the positions and states of safety devices (such as the emergency stop button, emergency automatic stop switching of teach pendant, etc.).
- Teachers shall pay special attention to make other people away from the range of manipulator
- Before starting the manipulator, first confirm that there is no people and no abnormality in the range of manipulator.
- After the teaching is over, be sure to perform the test run following the steps below:

  Step1. At low speed, execute at least one cycle intermittently to confirm no abnormality.

  Step2. At low speed, execute at least one cycle continuously to confirm no abnormality

  Step3. At intermediate speed, execute at least one cycle continuously to confirm no abnormality

  Step4. At operating speed, execute at least one cycle continuously to confirm no abnormality

  Step5. Execute the program in automatic operation mode.

- The teacher must evacuate outside the safety fence when the operator operates automatically.

Safety of repair engineer

To ensure the safety of repair engineer, full attention shall be paid to the following items:

- Never enter the range of manipulator while the manipulator is running.
- Perform the repair operation while the controller is powered off if possible. Main circuit breaker shall be locked to prevent other personnel from turning on the power.
- If it is Inevitable to enter the range of manipulator when it is powered on, you shall first press the emergency stop button of control cabinet or teach pendant. In addition, the operators shall hang the "Repairing" sign to remind other people not to operate the manipulator.
- Before performing a repair, verify that the manipulator or peripheral equipment is in a safe status.
- Do not perform the automatic operation when there is someone in the range of manipulator.
- When working near the walls and appliances, or when several operators are close to each other, be careful not to block the escape routes of other operators.
- When the manipulator is equipped with a tool, and there are movable devices such as conveyor belts in addition to the manipulator, pay attention to the operation of these devices.
- A person who is familiar with the manipulator system and is able to detect the danger shall be assigned next to the operating panel and operating box so that he can press the emergency stop button at any time.
- When replacing or reassembling the parts, be sure to prevent the foreign matters from sticking or entering.
- In case of the repair inside the controller, If the unit, printed circuit board, etc. may be contacted, be sure to disconnect the power supply of main circuit breaker of controller to prevent electric shock.
- Be sure to replace with the parts designated by us.
- When the manipulator system is restarted after the repair operation, it shall be confirmed in advance that there are no people in the range of manipulator, and the manipulator and peripheral equipment are in a normal status.

Safety of peripheral equipment

Precautions in terms of procedures:

- The detection devices such as the limit switch shall be used to detect the dangerous status, and the manipulator shall be stopped as needed according to the signals of detection device.
- In case of abnormalities of other manipulators or peripheral equipment, the measures shall be taken, such as stopping the manipulator, even if there is no abnormality in the manipulator.
- For the system of which the manipulator is operating synchronously with the peripheral equipment, special care shall be taken to avoid the interference with each other.

- The manipulator may be interlocked with peripheral equipment and the manipulator may be stopped if required so as to control the status of all devices in the system from the manipulator.

Mechanical precautions:

- Manipulator system shall be kept clean and the use environments shall be free of grease, water, dust, etc.
- Do not use the cutting fluids and cleaning agents of unknown nature.
- Limit switches and mechanical brakes shall be used to limit the operation of manipulator to avoid the collisions between the manipulator and peripheral equipment.
- User cables and hoses shall not be added to the manipulator.
- When installing the cable outside the manipulator, do not interfere with the movement of machine.
- For the models of which the cable is exposed, do not conduct the modification that will interfere with the exposed part of cable.
- When installing the external device on the manipulator, be sure not to interfere with other parts of manipulator.
- For the manipulator in action, the frequent power-off operation via the emergency stop button may lead to the fault of manipulator.

Mechanical safety of manipulator

Precautions for operation:

When the manipulator is operated in slow feed mode, the operators shall be highly vigilant regardless of the circumstances and quickly respond to various problems.

Precautions in terms of procedures:

If the ranges of multiple manipulators overlap, care shall be taken to avoid the interference between manipulators.

Be sure to specify an operation origin for the manipulator program and create a program that starts and ends at the origin, so that it is clear from the outside whether the manipulator operation has ended.

Mechanism precautions:

The working environments of manipulator shall be kept clean and free of grease, water, dust, etc.

Safety of end effector

When controlling various types of transmissions (pneumatic, hydraulic, and electrical), after issuing the control command, be sure to fully consider the time difference from the issuance to the actual action and conduct the control with certain room of extension and retraction.

A detection unit shall be set on the end effector to monitor the status of end effector and control the action of manipulator.

Contents

1 Overview and basic composition of manipulator

1.1 Overview of industrial Robot

Industrial robot consists of the following parts are as shown in Figure 1-1:

- Manipulator
- Control cabinet
- Teach pendant
- Connecting [power supply] cable,etc.

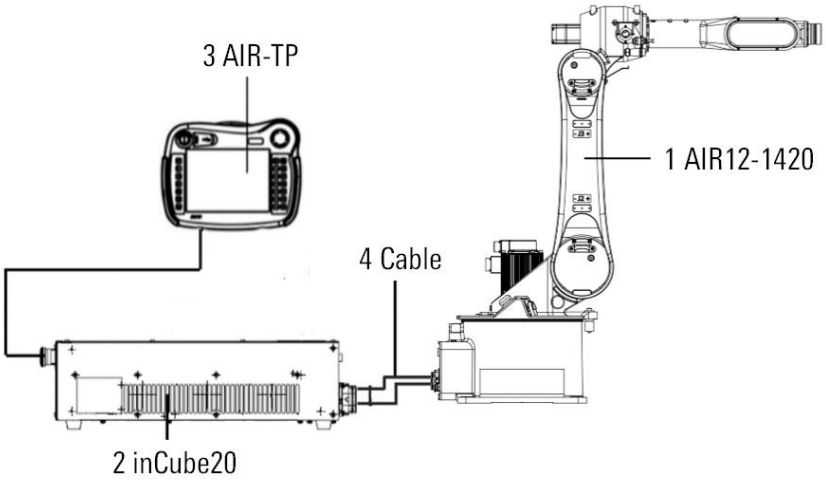


Figure 1-1 Composition of AIR12-1420 Robot System

Figure 1-1 show the example of the composition of an industrial robot system, in which:

1 Manipulator	2 Control cabinet
3 Teach pendant	4 Connect cables (power supply)

1.2 Basic composition

Manipulator refers to the mechanism of robot system to grab or move the objects (tools or workpieces), also known as the robot body. This manipulator is the 6-DOF tandem industrial robot that consists of three swing axes and three rotating axes.

Manipulator and the names of its various parts are as shown in Figure 1-2.

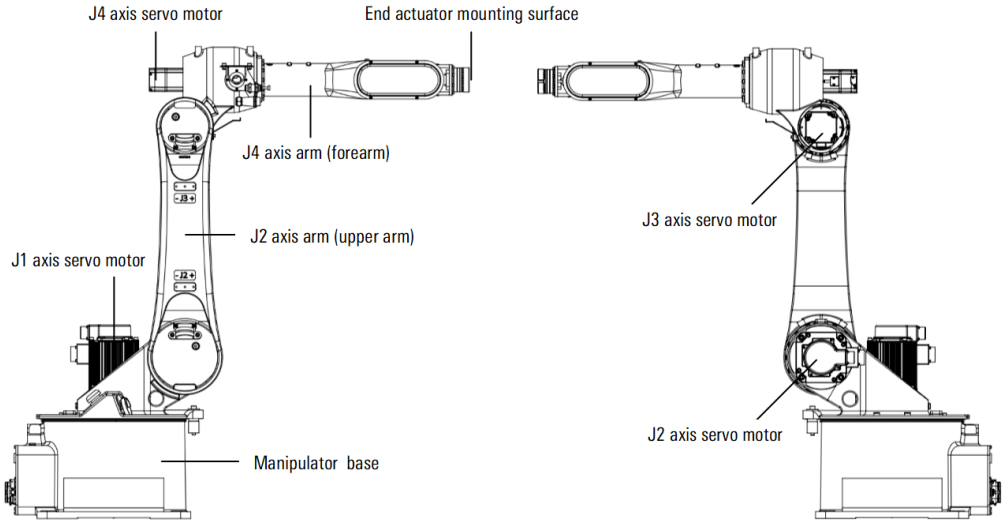


Figure 1-2 AIR12-1420 robot body and its various parts

1.3 Basic specifications

The basic specifications of the manipulator are as shown in Table 1-1:

Table 1-1 Basic Specifications of the Robot

Parameter		Value
Coordinate form		6-DOF articulated robot
Number of control axes		6 axes (J1,J2,J3,J4,J5,J6)
Mounting mode		Ground installation, hoisting and wall mounting
Range (upper limit/ lower limit)	J1*	-170° ~170°
	J2	-85° ~150°
	J3	-95° ~170°
	J4	-195° ~195°
	J5	-135° ~135°
	J6	-360° ~360°
Max. speed	J1	220° /s
	J2	230° /s
	J3	260° /s
	J4	440° /s
	J5	440° /s
	J6	700° /s
Transport capacity	Wrist	12kg
	Elbow	12kg
Drive mode		Electrical servo drive with AC servo motor

Parameter	Value
Repeated positioning accuracy	± 0.03mm
Robot weight	182kg
Noise	70dB
IP rating	IP54(wrist IP67)
Mounting conditions	■ Ambient temperature: 0℃~45℃ ■ Humidity: not more than 95% at constant temperature without condensation ■ Allowable altitude: not more than 1000m above sea level ■ No corrosive, flammable or explosive gases

*: If the mechanical limit of J1 axle is removed, the range may reach -180 to 180° .

1.4 Environmental requirements for operation

Please see Table 1-2 for operating environment requirements.

Table 1-2 Environmental requirements for manipulator

Parameter	Value	
Temperature	Min. temperature	0℃
	Max. temperature	45℃
	 Caution	It is recommended to warm-up the robot for several minutes before using the manipulator when the ambient temperature is lower than 10℃. Otherwise, there is a risk that the robot stops or run with lower performance due to temperature dependent grease viscosity.
Relative humidity	The relative humidity in the installation environment of manipulator shall not be more than 95% as specified in ″IEC 60721-3-3-2002 Classification of environmental conditions″.	
Altitude	The altitude of normal operation environment for manipulator shall not exceed 1,000 m, and the manipulator shall be derated from 1,000m to 4,000m.	
Anti-vibration	Robot manipulator shall be used in an environment where there is no vibration. The limit frequency of ambient vibration is 22Hz and the amplitude shall not be exceeded 0.15mm.	
Special environmental requirement	Do not operate this manipulator in the flammable, explosive and corrosive environments.	

2 Product label and meaning

2.1 Safety label

The manipulator safety sign (as shown in Figure 2-1) is pasted on the eye-catching position on the back of the manipulator upper arm.

Figure 2-1 Safety sign on the manipulator

Danger	The sign reminds the operators to stay away from the working area of manipulator. Otherwise, the injuries and deaths may be caused by manipulator.

2.2 Manipulator nameplate

Manipulator nameplate is as shown in Figure 2-2 and usually located on the base. The nameplate indicates the type, range, serial number, date, etc.

配天机器人技术有限公司
Peitian Robotics Technology Co., Ltd.

型号	Type
产品号	Product No.
序列号	Serial No.
生产日期	Date
重量	Weight
负载	Load
运动半径	Range

Figure 2-2 Manipulator Nameplate

2.3 Direction sign of each axis

"+" or "-" sign is provided at the rotating or swinging joints of axes 1~6 of manipulator as shown in Figure 2-3 to indicate the moving direction of each axle. "J1" in sign represents the axis 1 (other axes are represented by the corresponding numbers), "+" indicates the positive direction, and "-" indicates the negative direction.

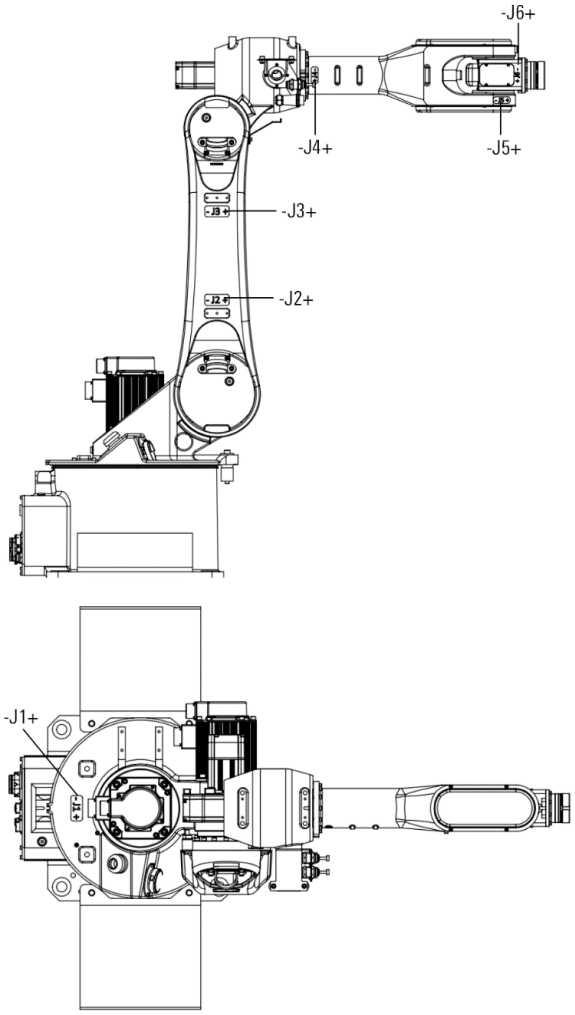


Figure 2-3 Direction identification of each axis on AIR12-1420 manipulator

3 Preparation before installation

3.1 Checking items

Following requirements shall be strictly adhered to before installation:

- Ensure that the installers pass the relevant training of company and perform the installation according to the international and local laws and regulations.
- After the unpacking, make sure that the product is not bumped or damaged.
- Make sure that the carrier bracket, swinging ring screws, etc. are installed to the manipulator as required.
- Make sure the installation environments are as required by *Chapter1.4*
- Make sure that the installation site can withstand the pressure or pull from the manipulator and its load.

3.2 Installation tool and required connectors for manipulator

The following tools may be required to install the manipulator (more tools may be required, depending on the installation method).

- A set of Internal hexagonal wrench
- Adjustable wrench
- Torque wrenches of different specifications, etc.

The following connectors may be required to install the manipulator (more connectors may be required, depending on the installation method).

- Several M20 screws with appropriate length and strength grade 12.9 or other hexagonal head cap screws
- A number of chemical bolts of appropriate length and strength grade not less than 4.8.
- Several spring pads of Φ20 or other specifications.
- Several round pins (Φ 10 mm). Please see *Chapter4.2* in this manual for details

4 Installation of manipulator

4.1 Technological specifications

The force applied to the ground is shown in Table 4-1 when the manipulator moves. Enough thought shall be given to the strength of foundation installation surface for the installation of manipulator. The installation ground inclination shall be less than 5° for manipulator.

Table 4-1 Force in relation to the installation ground

Load type	Force/torque/mass (in operation)	Force/torque/mass (emergency stop)
Vertical force Fv	3810N	4680N
horizontal force Fh	3050N	3940N
Overturning moment Mk	2420Nm	5330Nm
Rotating torque Mr	970Nm	2660Nm
Total load mass	24kg (12kg+12kg)	

Dimensions of manipulator base are shown in Figure 4-1:

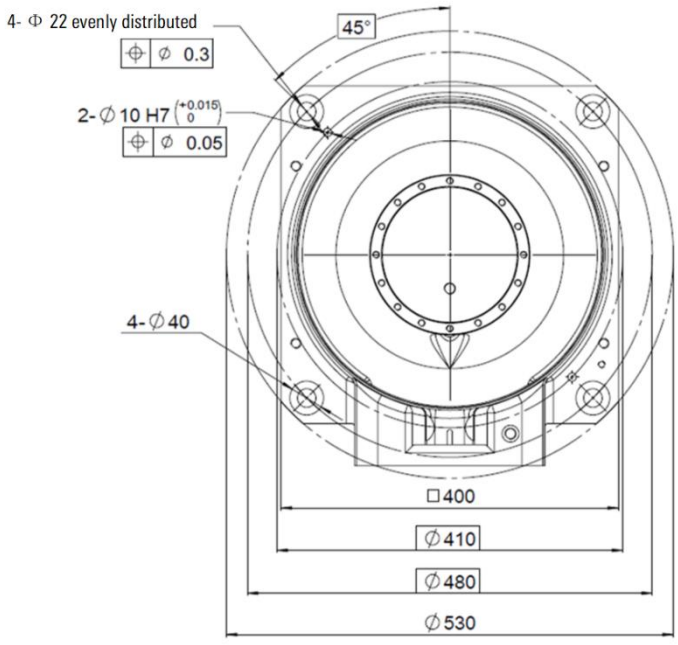


Figure 4-1 Dimensions of manipulator base interface

4.2 Fixing mode

The manipulator supports three mounting attitudes: ground mounting, hoisting and wall mounting. The fixing methods on the installation contact surfaces of different materials are different. When the base is fixed on the concrete floor or support, the following fixing methods can be referred to for installation:

- Grounding fixing

■ Bracket fixing

Prompt

- Specific fixing mode depends on the usage environments.
- Strength of chemical bolt is subject to the strength of concrete. Therefore, the safety shall be fully considered according to the design guidelines of manufacturer before the construction.

he names and specifications of parts required to fix the manipulator are as shown in Table 4-2:

Table 4-2 Parts for fixing manipulator

Part Name	Remarks	Grounding Fixing	Bracket Fixing
Fixing screw	Four M20x40 (Grade 12.9)	○	○
Fixing screw	Eight M20x50 (Grade 12.9)		○
Chemical bolt	Eight M20 (Not lower than 4.8)	○	
Fixing plate of robot	Thickness 25mm,1 piece	○	
Adapter plate	Thickness 25mm,4 pieces		○

Prompt

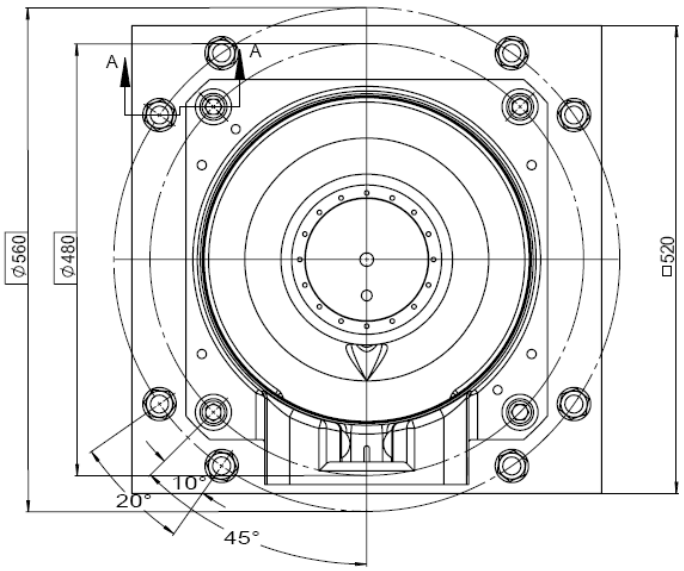
- There shall be no insulating materials between the fixing plate and mounting bracket of robot and the manipulator and concrete.
- Mark "○" means that the part is in need
- Bracket shall be firmly installed on the ground with the strength not less than the fixing strength between the fixing plate of robot and the ground for the ground fixing (mode 1).

Grounding fixing

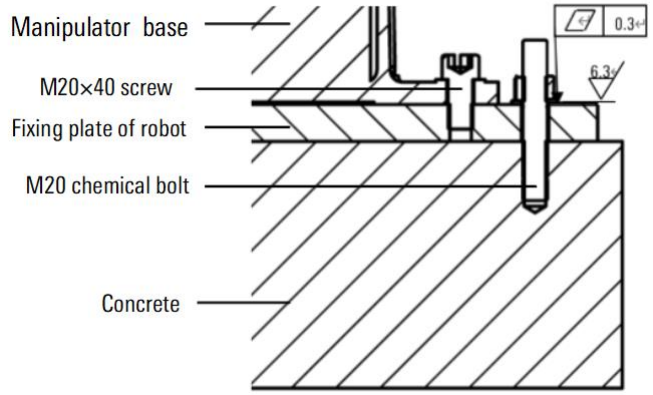
Fixing steps:

Step1. Hold the fixing plate of robot close to the mounting surface and secure it with eight M20 chemical bolts (strength not less than Grade 4.8).

Step2. Install the manipulator base on the fixing plate with four M20x40 bolts (Grade 12.9).



(a)



(b)

Figure 4-2 Diagram of ground fixing of manipulator

Prompt

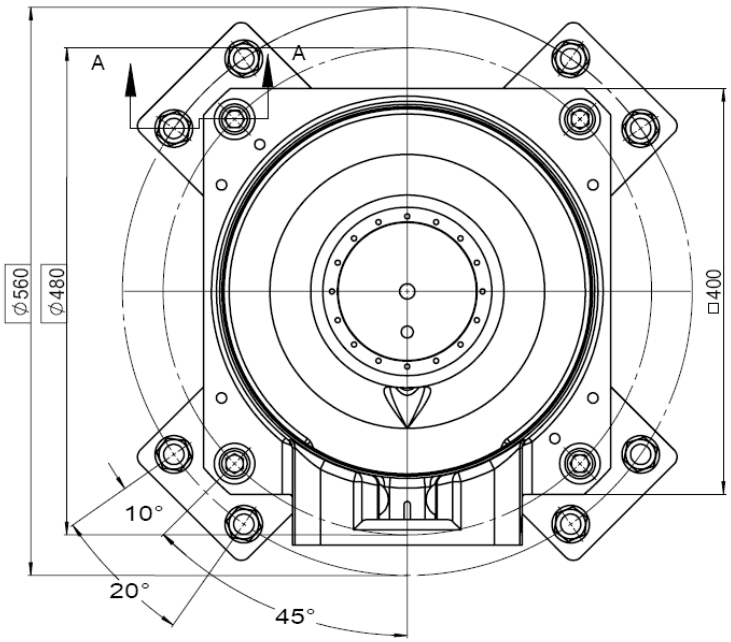
Fixing plate surface shall meet certain roughness and flatness requirements as detailed in Figure 4-2.

Bracket Fixing

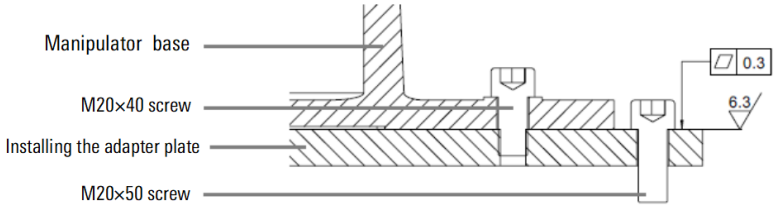
Fixing steps:

Step1. Fix 4 adapter plates on the bracket with 8 M20x50 bolts (strength grade 12.9).

Step2. Four M20x40 bolts (strength grade 12.9) are used to fix the manipulator base on the adapter plate.



(a)



(b)

Figure 4-3 diagram of fixing the manipulator bracket

Prompt	The mounting surface of the bracket should meet certain flatness requirements, see Figure 4-3 for details.
Warning	■ The length of the manipulator fixing screw M20 should not be shorter than 40mm. Too short length will cause accidents such as poor fixing. ■ When installing the manipulator on the ceiling, it is necessary to increase the length of the manipulator fixing screw to 45mm, while ensuring that the thickness of the mounting plate is not less than 30mm.

5 Manipulator Electrical Connections

5.1 AIR12-1420 electrical interface type

The AIR12-1420C manipulator base is equipped with heavy-duty connectors, brake buttons, air pipe connectors, and user IO input interfaces. On the forearm, there are user IO output interfaces and air pipe connectors. As shown in Figure 5-1, the heavy-duty connectors are located at the lower left of the base, with three brake buttons directly above them. Two ϕ 10 quick air pipe connectors are located at the lower right, which can be directly inserted with ϕ 10 air pipes after removing the blind plugs. Above the air pipe connectors are the user IO input interfaces. As shown in Figure 5-2, there are two ϕ 10 quick air pipe connectors and user IO output interfaces on the left side of the forearm.

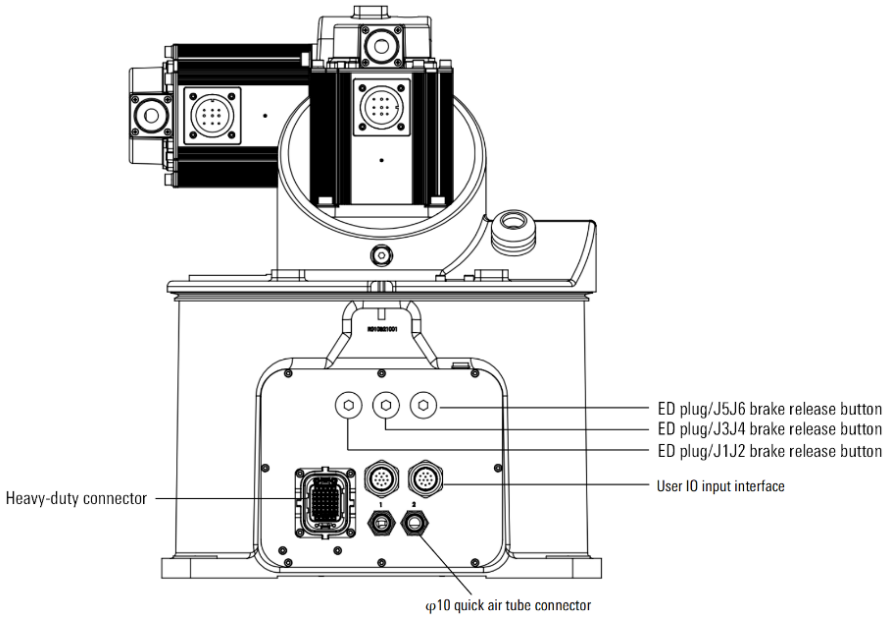


Figure 5-1 Diagram of release brake button

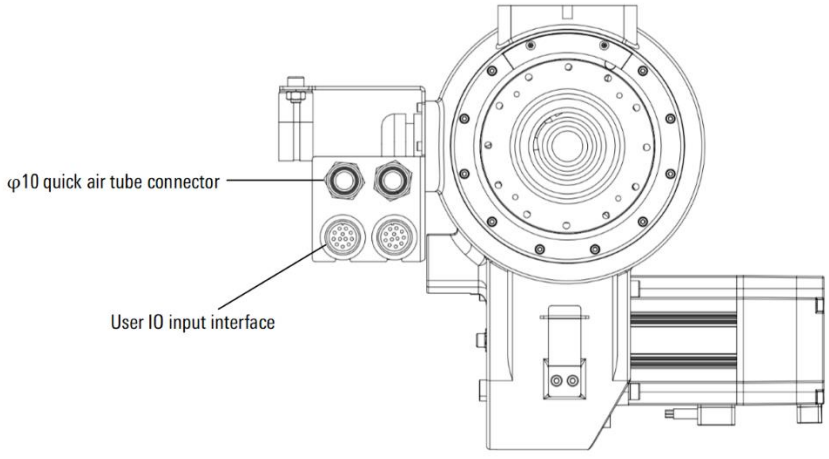


Figure 5-2 Diagram of manipulator forearm interface

Operating steps for manually releasing the brake:

Step1. To prevent the axis from falling due to gravity when the brake is released, the manipulator needs to be fixed;

Step2. Use a wrench to remove the ED plug on the base to see the brake release button inside the base;

Step3. Connect the manipulator to the control cabinet and the control cabinet to the power supply. See *Chapter 6.2* of this manual for specific operations;

Step4. Press and hold the brake release button to release the brakes of the six axes of the manipulator.

Caution

After the brake is released manually, please reinstall the ED plug on the base of the manipulator to prevent dust or liquid from invading the inside of the manipulator.

5.2 Heavy-duty manipulator

There are aviation plugs and heavy load connectors on the manipulator. The specific location of heavy load connector PQ50WASX-46P-UNIT (10) is shown in Figure 5-3.

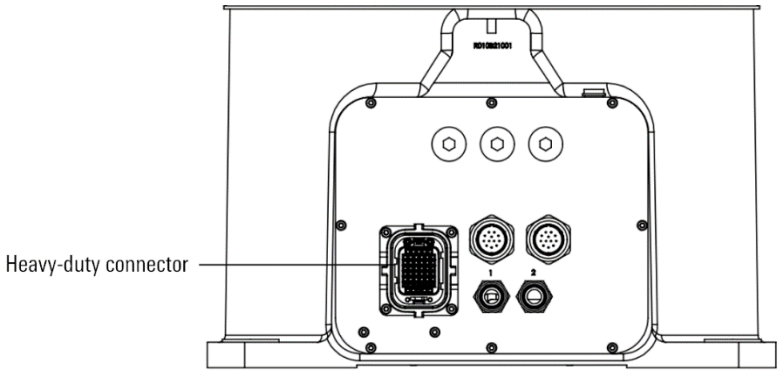


Figure 5-3 Heavy load connector on the manipulator

5.3 Definition of heavy-duty interface

The heavy load interface definition of the manipulator is shown in Figure 5-4, Table 5-1, Table 5-2 and Table 5-3.

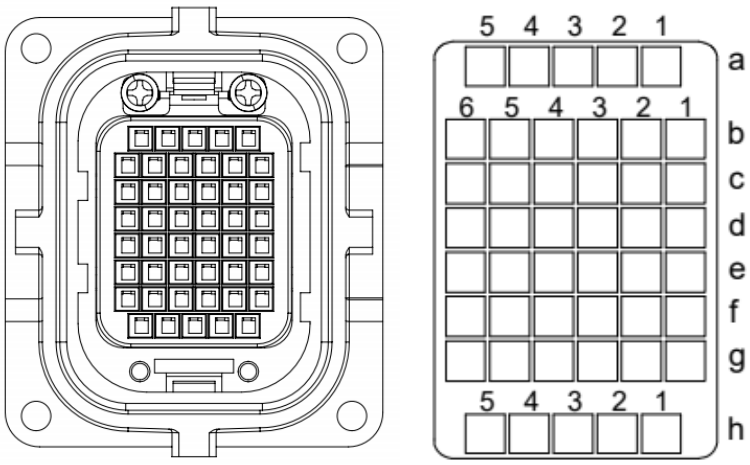


Figure 5-4 Manipulator heavy load connector PQ50WASX-46P-UNIT (10)

Table 5-1 Manipulator heavy load interface definition (power line part)

Signal name	Axis number	Pin No	Signal name	Axis number	Pin No
U1	1 axis	1f	U4	4 axis	5f
V1	1 axis	1g	V4	4 axis	5g
W1	1 axis	1h	W4	4 axis	5h
PE	1 axis	1d	PE	4 axis	4d
U2	2 axis	4f	U5	5 axis	3f
V2	2 axis	4g	V5	5 axis	3g
W2	2 axis	4h	W5	5 axis	3h
PE	2 axis	4d	PE	5 axis	1d
U3	3 axis	2f	U6	6 axis	5e
V3	3 axis	2g	V6	6 axis	6f
W3	3 axis	2h	W6	6 axis	6g
PE	3 axis	1d	PE	6 axis	4d

Table 5-2 Manipulator heavy load interface definition (encoder line part)

Signal name	Axis number	Pin No	Signal name	Axis number	Pin No
J1_PS+	1 axis	1a	J4_PS+	4 axis	4a
J1_PS-	1 axis	1b	J4_PS-	4 axis	4b
J2_PS+	2 axis	2a	J5_PS+	5 axis	5a
J2_PS-	2 axis	2b	J5_PS-	5 axis	5b
J3_PS+	3 axis	3a	J6_PS+	6 axis	6b
J3_PS-	3 axis	3b	J6_PS-	6 axis	6c
Encoder 0V	1-6 axis	1c	Encoder 24V	1-6 axis	2c

Table 5-3 Manipulator heavy-duty interface definition (ENP part)

Signal name	Axis number	Pin No
24V_BR+	1 axis ~6 axis	3e
24V_BR+2_0	1 axis ~6 axis	2e
GND_24VBR	1 axis ~6 axis	1e
E_NAME_BOARD_RS485_A	-	4c
E_NAME_BOARD_RS485_B	-	3c

When the robot is connected, pay attention to the one-to-one correspondence between the heavy load on the manipulator and the heavy load on the control cabinet.

6 Accessories and connectors on manipulator

6.1 Examples of accessory types

Accessories of manipulator are mainly including mechanical Grabber as shown in Figure 6-1, hydraulic or pneumatic suction cup as shown in Figure 6-2, welding torch as shown in Figure 6-3, infrared device, visual device, cutting-off machine, etc..

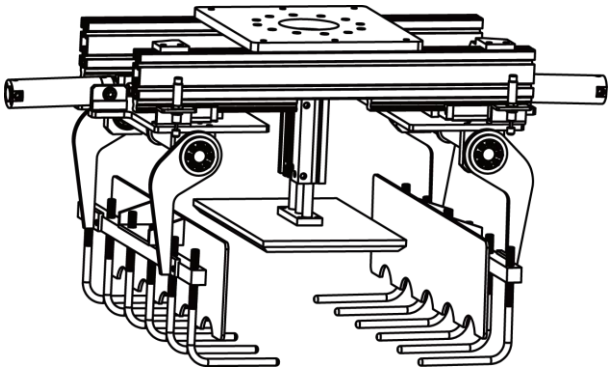


Figure 6-1 Mechanical Grabber

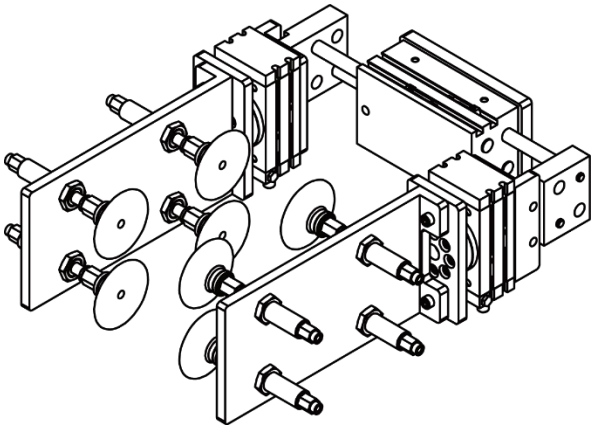


Figure 6-2 Hydraulic or Pneumatic Suction Cup

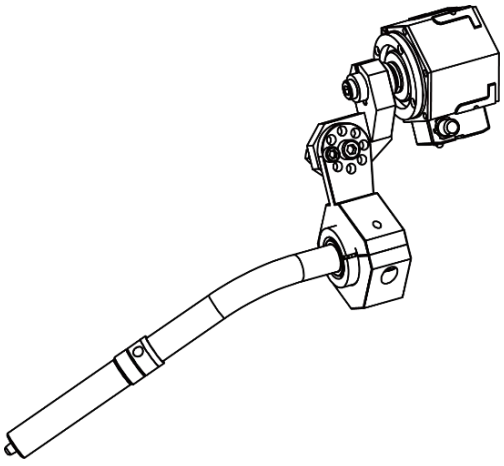


Figure 6-3 Welding Torch

6.2 Heavy-duty connection mode

Connecting with Accessories

Accessories can be attached to the manipulator through the flange directly or indirectly like connection between the payload and manipulator. It is detailed in *Chapter7.6* of this manual.

Connecting with the Control Cabinet

The manipulator is connected to the control cabinet through a cable (i.e. heavy load line). The control cabinet and its interface are shown in Figure 6-4 below. Refer to the description in *Chapter5.2* of this manual for the definition of heavy load line connector. The heavy load line does not distinguish between the manipulator end and the control cabinet end (see Figure 6-4 and Figure 6-5). For more detailed information, please refer to the corresponding manual of the electrical part.

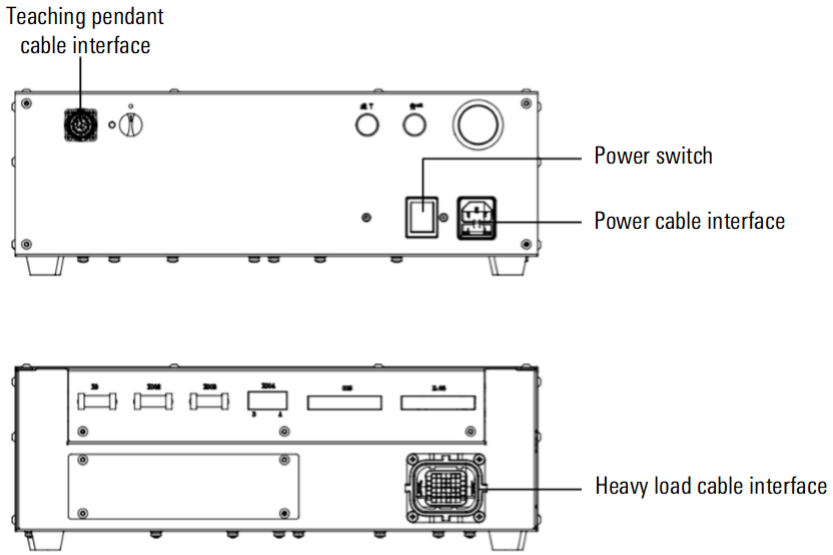


Figure 6-4 Definition of control cabinet cable connector

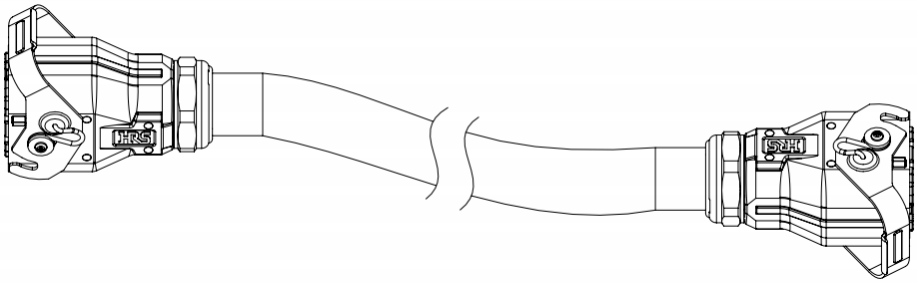


Figure 6-5 Diagram of heavy load line

7 Manipulator performance parameters

7.1 Basic specifications

For the basic specifications of the manipulator, see *Chapter1.3* of this manual.

7.2 Dimensions and working range of each axis

The movement range of each axis of the manipulator is shown in Table 7-1.

Table 7-1 Manipulator's movement range of each axis

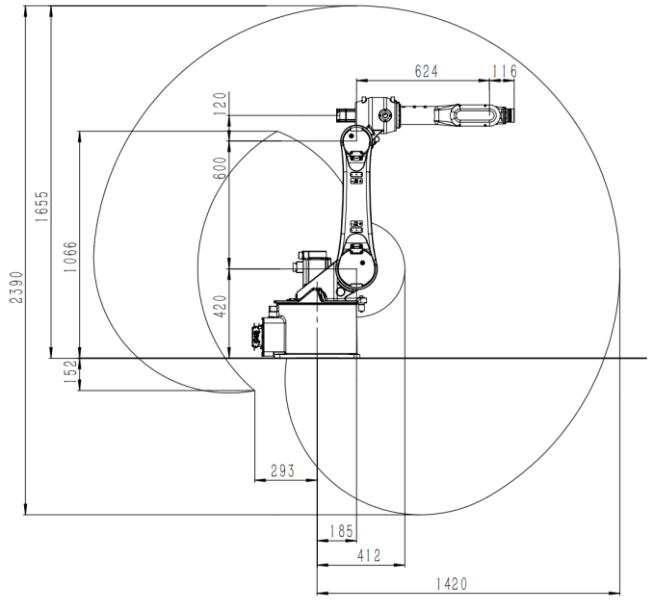
Shaft number	Range of motion (°)
J1*	-170~+170
J2	-85~+150
J3	-95~+170
J4	-195~+195
J5	-135~+135
J6	-360~+360


Prompt

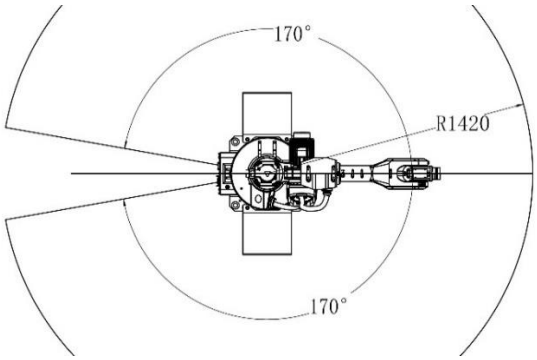
"*": If the mechanical limit of the J1 axis is removed, the movement range can reach -180° ~ 180° .

Figure 7-1 show the operating range of the manipulator.

When installing peripheral equipment, pay attention to avoid interfering with the main part of the robot and the range of motion. Unit: mm.



(a)



(b)

Figure 7-1 Working range of AIR12-1420 manipulator

7.3 Mechanical limit

Each axis has a zero point and a movable range. As long as the origin position is not lost due to servo system abnormalities and system errors, the robot is controlled to move within its movable range. In addition, in order to further ensure safety, mechanical brakes are provided on some axes to limit the movable range.

Figure 7-2 shows the position of the mechanical brake.

Do not modify the mechanical brake, etc., otherwise the robot may not stop normally.

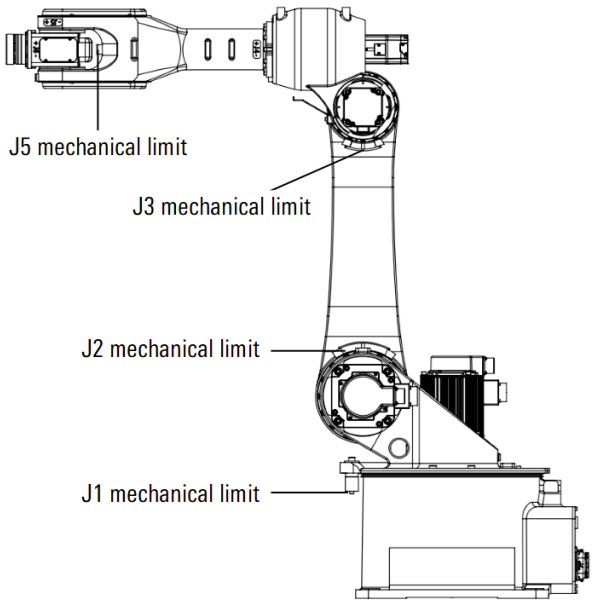


Figure 7-2 The mechanical brake on the manipulator

7.4 Speed of each axis

The maximum angular velocity of each axis of the manipulator is as specified in Table 7-2.

Table 7-2 Manipulator maximum angular velocity of each axis

Axis number	Allowable maximum angular velocity (° /s)
J1	220°/s
J2	230°/s
J3	260°/s
J4	440°/s
J5	440°/s
J6	700°/s

7.5 Output flange size

The manipulator output flange specifications and connection dimensions and schematic diagrams are shown in Table 7-3 and Figure 7-3. For screw tightening torque, refer to "Appendix B Screw strength and screw tightening torque table (Nm)".

Table 7-3 The manipulator output mechanical interface specifications

Parameter	Value
Positioning circle diameter	31.5mm or 63mm
Diameter of threaded hole indexing circle	50mm
Screw grade	12.9 level

Parameter	Value
Screw diameter	M6
Screw quantity	4
Diameter of threaded hole indexing circle	6mm
Screw grade	GB/T 70.1-2000

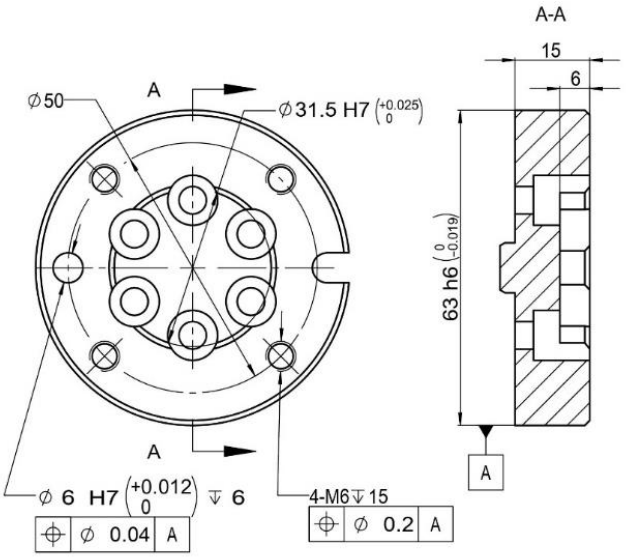


Figure 7-3 Diagram of the flange size of the wrist of the manipulator

Warning

When installing the fixture, the screws and positioning pins used should fully consider the depth of the threaded hole and the pin hole, and the installation length is prohibited to exceed the depth of the threaded hole (9mm) and the depth of the pin hole (4mm), otherwise it will damage the wrist of the manipulator.

7.6 Load and installation method

Calculation method of inertia moment

Inertia moment refers to the difficulty of rotation of the load (clamp end + workpiece) when the robot joint starts to rotate (inertia). The moment of inertia increases with the weight of the load and eccentricity. Since this will also increase the load on the joints, please ensure that the inertia moment is within the allowable range.

The moment M (N · m) and inertia moment I (kgm^2) can be obtained when the load (clamp end + workpiece) volume is small by the following formula.

$$M(N \cdot m) = m(kg) \times L(m) \times g(m/s^2)$$

$$I(kgm^2) = m(kg) \times L^2(m)$$

Where, M is the load weight (kg), L is the load eccentricity (m), and g is the gravitational acceleration (m/s^2).

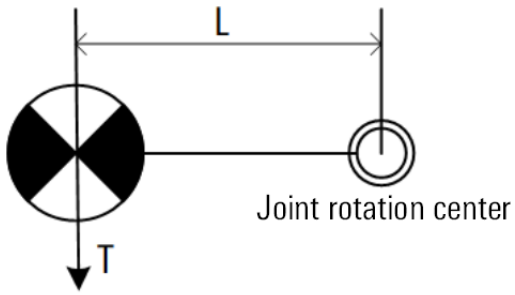
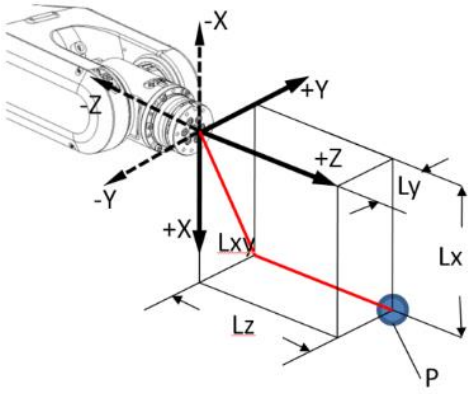


Figure 7-4 Diagram of load eccentricity

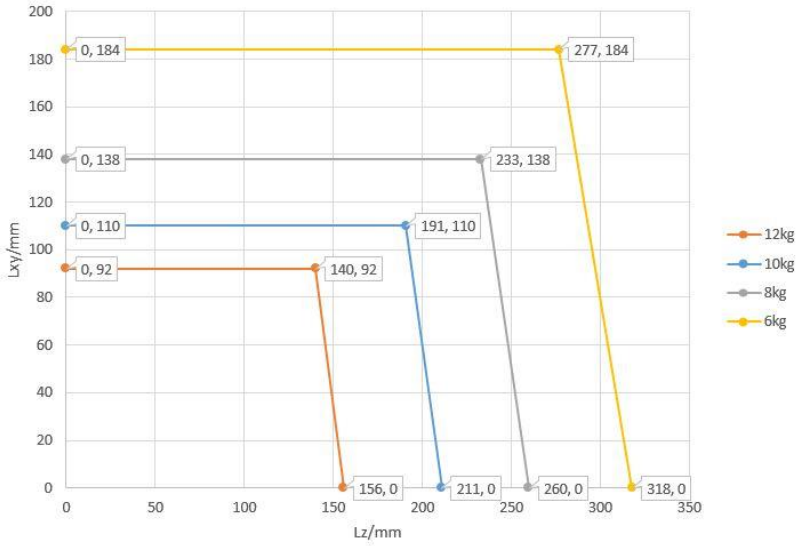
Manipulator wrist load installation

The manipulator wrist load diagram is as shown in Figure 7-5.

- Load shall be inside the range as shown in the diagram.
- Allowable torque of J4 shall be less than 26Nm while J5 less than 26Nm and J6 less than 10.8Nm.
- Allowable moment of inertia of J4 shall be less than 1.35kgm^2 while J5 1.35kgm^2 and J6 0.24kgm^2.
- See Figure 7-5 for more manipulator specification.



(a)



(b)

Figure 7-5 Diagram of the manipulator's wrist load center of mass position

Manipulator 3-axis elbow equipment installation

The specifications and dimensions of the equipment mounting hole at the elbow of the J3 axis of the manipulator are shown in Figure 7-6.

- External device which may be installed on manipulator elbow shall be not more than 12kg.
- Centroid position of elbow load shall be located inside the area sized 135mmx66mm for installing screw as shown in Figure 7-6.
- Distance between Centroid and installing face shall be not more than 60mm.

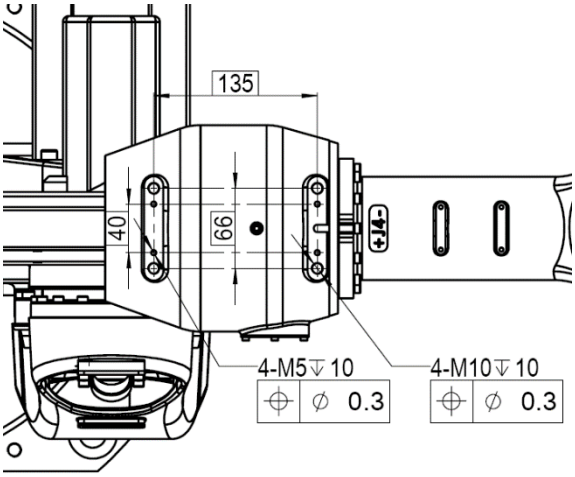


Figure 7-6 Diagram of the manipulator elbow load interface

Reliability shall be considered sufficiently when the external device is installed. The screw, grade 12.9, is proposed to use according to defined torque. Thread locker shall be daubed on the thread, otherwise screw may loosen or crack that may cause accident after long-time running.

Warning

- When installing the fixture, the screws and positioning pins used should fully consider the depth of the threaded hole and the pin hole. The installation length is prohibited to exceed the depth of the threaded hole (9mm) and the depth of the pin hole (4mm), otherwise it will damage the wrist of the manipulator.
- When installing the equipment, the screw used shall fully consider the depth of the threaded hole, and the installation length shall not exceed the depth of the threaded hole (10mm), otherwise the elbow of the operator will be damaged.
- Elbow load centroid must be not out of the aforesaid value, otherwise manipulator may not work or may have lower working life.
- Care shall be taken when installing peripheral equipment on the elbow to avoid the interference with the body and cable of robot while broken cable may lead unpredictable failure.

Other Installing Locations on Manipulator

There are other installing Locations considered to fix cable conveniently on the manipulator, as follows:

Fixing Location of Manipulator Forearm

Interface specification and size of manipulator forearm is as shown in Figure 7-7.

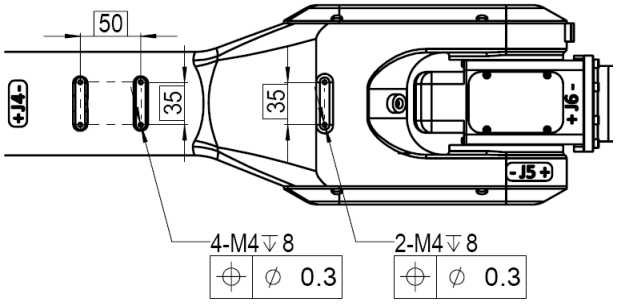


Figure 7-7 Diagram of the manipulator forearm interface

Fixing location of manipulator upper arm

Interface specification and size of manipulator upper arm is as shown in Figure 7-8.

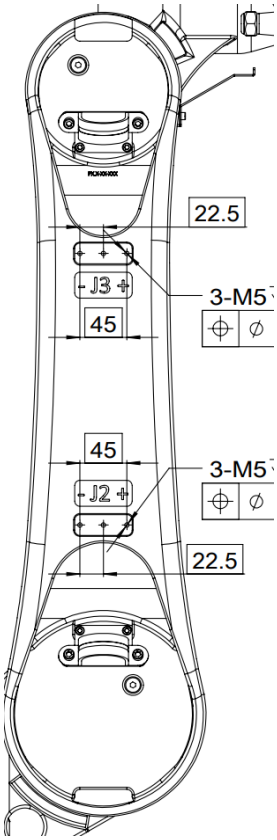


Figure 7-8 Diagram of AIR12-1420 manipulator upper arm

Fixing location of manipulator shoulder

Interface specification and size of manipulator shoulder is as shown in Figure 7-9.

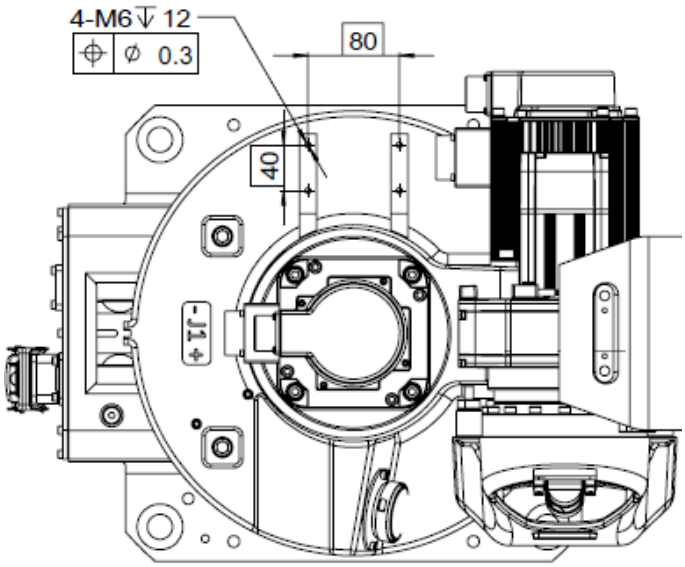


Figure 7-9 Diagram of AIR12-1420 manipulator shoulder

Caution	The installation hole may interfere with the motor aviation plug and cable during use. If necessary, add adapter parts.
Warning	Depth of screw must not exceed depth of thread hole when installing peripheral equipment, otherwise internal parts and cable of manipulator body may be damaged.

The parts stated above are designed for fixing cable. If it is used to install external device, follows shall be guaranteed:

- Forearm Load+Wrist Load<10kg
- Shoulder Load+Upper Arm Load+Elbow Load<12kg

Reliability shall be considered sufficiently when the external device is installed. The screw, grade 12.9, is proposed to use according to defined torque. Thread locker shall be daubed on the thread, otherwise screw may loosen or crack that may cause accident after long-time running.

8 Calibration of each axis of manipulator

8.1 Summary

This chapter introduces the situation that the manipulator needs to be calibrated and the zero-calibration method under different requirements.

8.2 The situations that require calibration are as follows

When the following situations occur in the manipulator, recalibration is required:

- There have been motor replacement or pulley removal and other maintenance.
- Replaced the encoder battery.
- Motor's encoder wire is loose or reinstalled.
- The manipulator has experienced a strong collision.
- Replaced the control cabinet or control system (for example: industrial computer).

8.3 Calibration position of each axis

The position of each axis of the manipulator is shown in Figure 8-1 below. The J3 axis is 90° after calibration, and the other axes are 0°.

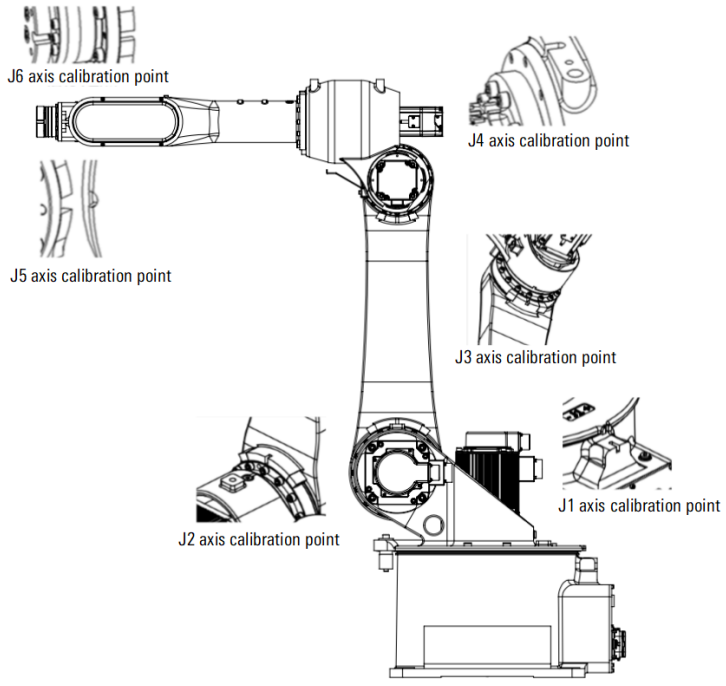


Figure 8-1 Diagram of zero point of each axis of AIR12-1420

Caution

- Robot calibration must always be performed under the same temperature conditions to avoid errors caused by thermal expansion and contraction.
- The industrial robot must be calibrated sequentially from the J1 axis to the J6 axis.

Calibration with high repeat positioning accuracy

During the operation of the operator, if there is no requirement for the path positioning accuracy as long as it has a high repeated positioning accuracy, the zero point of each axis can be calibrated according to the zero point of each axis shown in Figure 8-1, and the zero point of each axis can be aligned through visual observation, as shown in Figure 8-2.

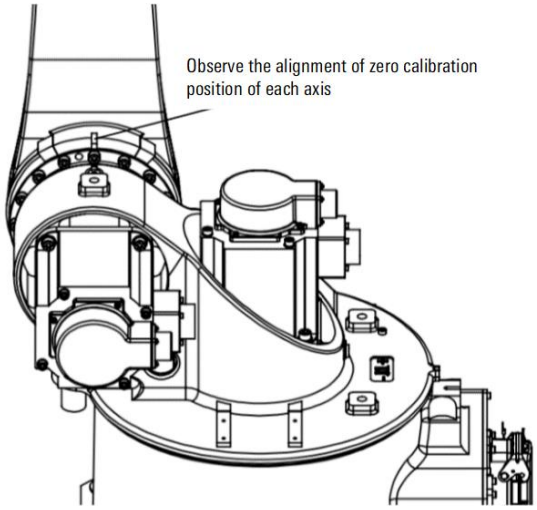


Figure 8-2 AIR12-1420 Zero point calibration by naked eye

Warning

During the calibration of the operator, speed shall be reduced as much as possible. The manipulator shall not enter the working range of the robot. After the robot stops moving, observe whether the zero scale on the axis position is aligned.

Calibration when there are rough requirements for path positioning accuracy

When there is a rough requirement for the path positioning accuracy, use the calibration block to calibrate, as shown in Figure 8-3.

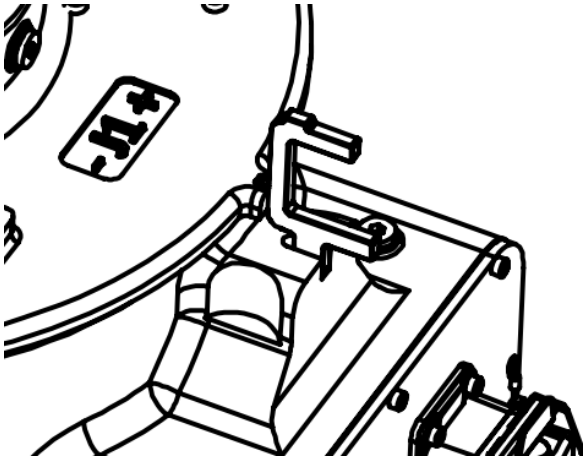


Figure 8-3 AIR12-1420 calibration block calibration method

Warning	During the calibration of the operator, speed shall be reduced as much as possible. The operator shall not enter the working range of the robot. After the robot stops moving, observe whether the zero scale on the axis position is aligned.
Prompt	When using the calibration block to calibrate the manipulator, first observe the basic alignment of the calibration slot with naked eyes, reduce the operating speed of the manipulator to the lowest manual gear, fine tune the axis position, and then use the calibration block to calibrate. After multiple fine adjustments, the calibration block can be inserted into two calibration slots at the same time, as shown in Figure 8-3.

Calibration with high path positioning accuracy

When the manipulator requires high path positioning accuracy, it is necessary to accurately calibrate and compensate the angle and length of each axis. You need to contact our company to use special equipment for calibration.

9 Transport and Handling

Prompt

Manipulator shall be equipped with the matching handling bracket. The incorrect handling method may cause the damage to manipulator. Manipulator posture during handling is subject to the description in *Chapter9.1* of this manual. Considerations are as shown in Figure 9-1 during transporting the manipulator.

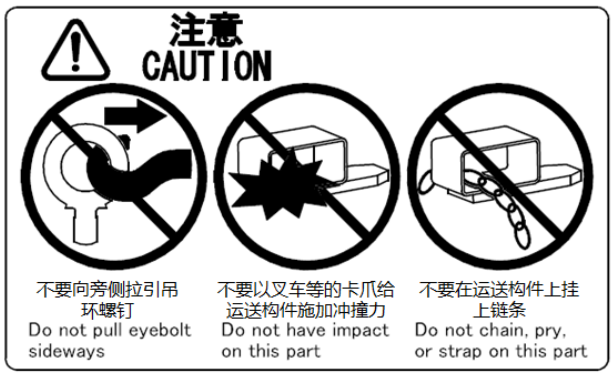


Figure 9-1 Considerations during transporting manipulator

During transporting manipulator, the followings shall be paid attention:

- Do not pull eyebolt sideways.
- Do not have impact on this part by grabber of forklift.
- Do not chain or strap on the transport component.

9.1 Handling posture

The one-to-six-axis posture of the manipulator is shown in Figure 9-2 and Table 9-1.

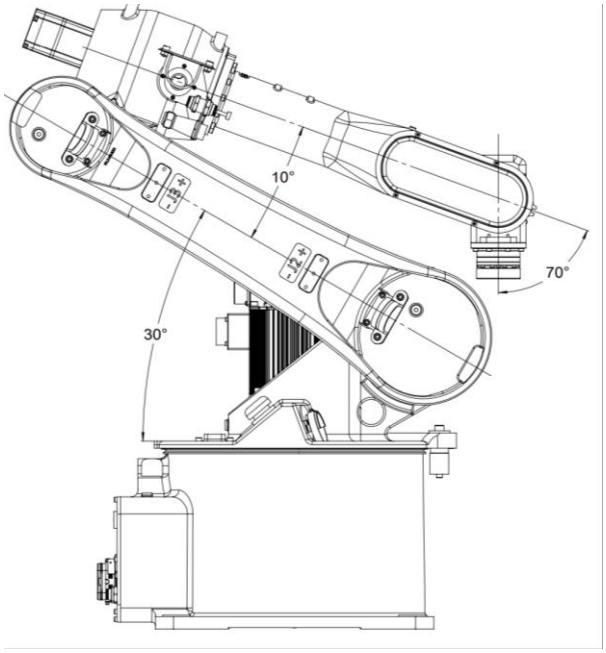


Figure 9-2 AIR12-1420 manipulator handling pose diagram

Table 9-1 Angle Values of Axes for Robot during Handling

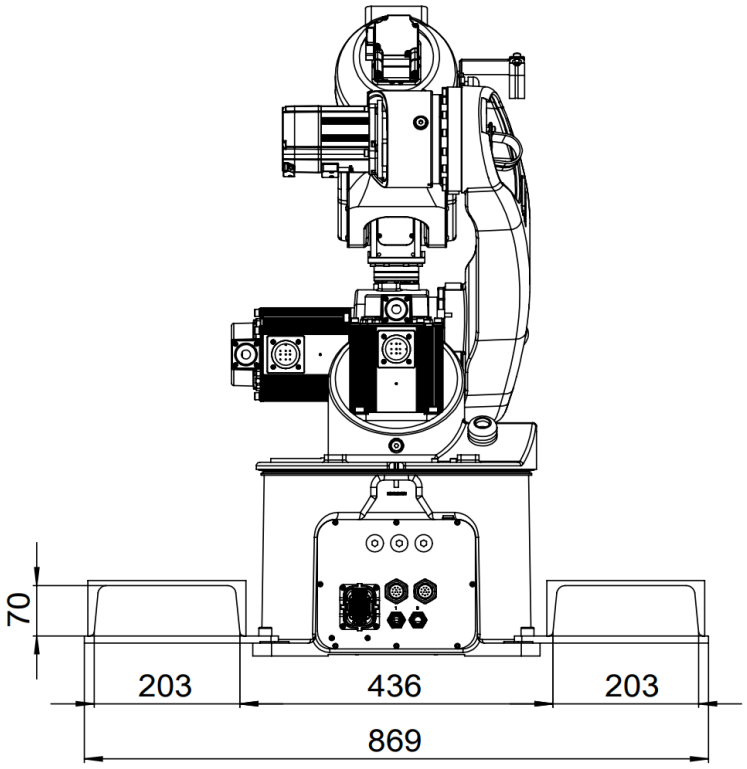
A1	A2	A3	A4	A5	A6
0	-60°	170°	0	70°	0

Warning

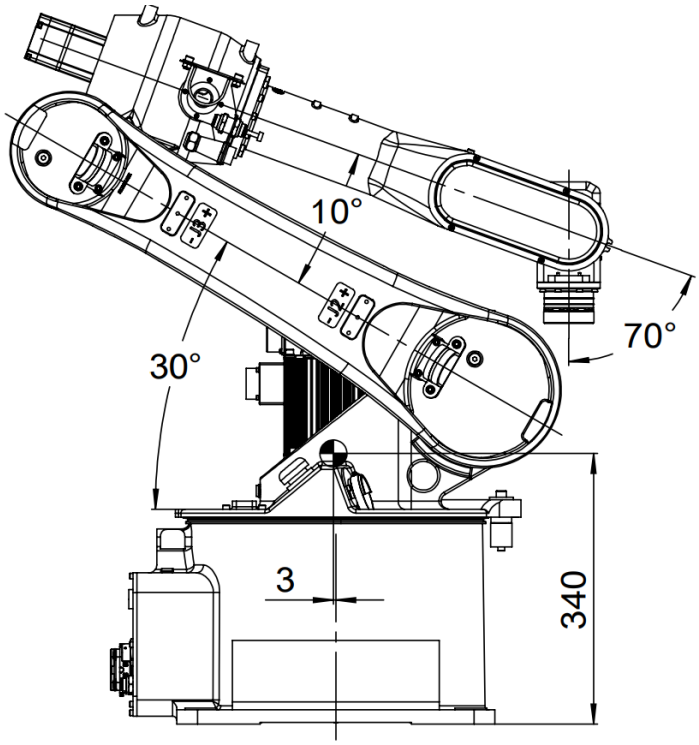
Manipulator shall be handled in strict accordance with the posture in the Table 9-1, otherwise it may fall due to unstable center of gravity.

9.2 Handling dimensions

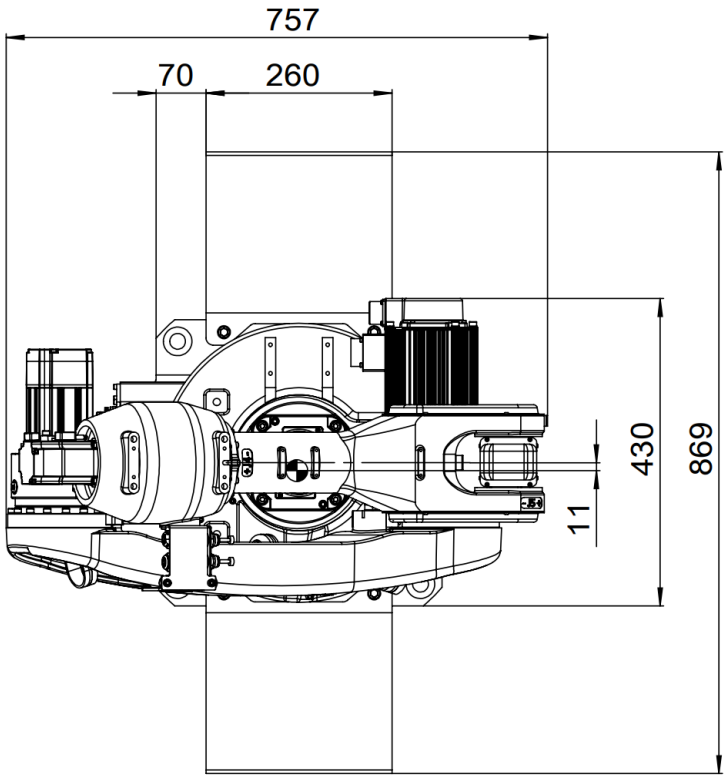
The dimensions of the three views of the manipulator during transportation are shown in Figure 9-3 (the actual size may be slightly larger than the size in the figure, so please pay attention).



(a)



(b)



(c)

Figure 9-3 AIR12-1420 size of manipulator during handling

9.3 Handling with forklift

Handling with forklift is as shown in Figure 9-4. Forklift shall meet the requirement for the weight of manipulator. The total weight of manipulator and handling device is about 203kg.

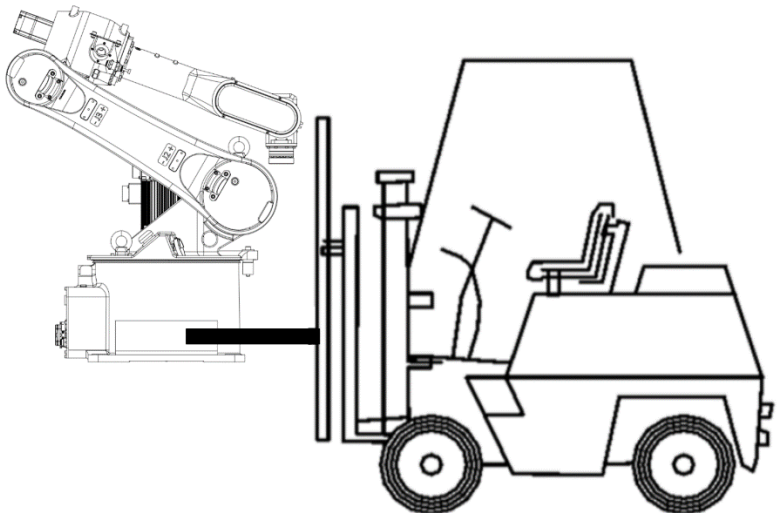


Figure 9-4 Diagram of AIR12-1420 handling with forklift

Manipulator shall be equipped with the matching handling bracket. The incorrect handling method may cause the damage to manipulator. Manipulator posture during handling is subject to the description in *Chapter9.1* of this manual.

9.4 Handling with swing ring

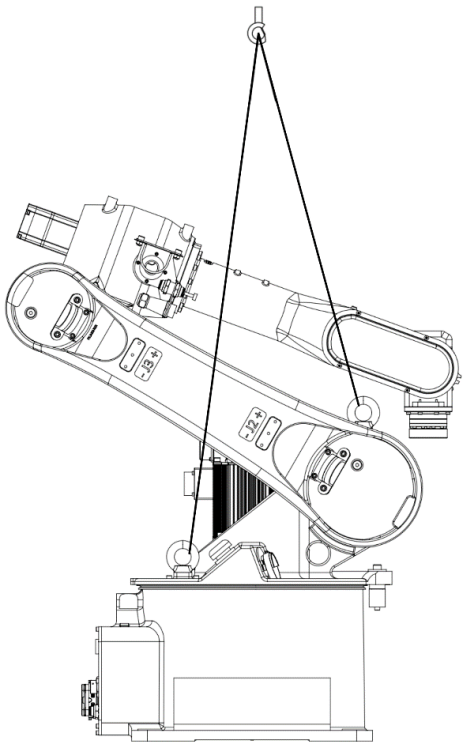


Figure 9-5 Diagram of AIR12-1420 manipulator handling with swinging ring

Handling with swinging ring is as shown in Figure 9-5, Lifting device shall meet the requirement for the weight of manipulator. The lifting ring is made of 20 or 25 # steel; The lifting ring is M12. The total weight of manipulator and handling device is about 205kg.

- When manipulator is handled with swinging ring, insert a soft object between the sling and manipulator to avoid the scratching on the manipulator body by sling.
- Manipulator may turn over when transported with swinging ring. During the handling, please take special care to keep the manipulator steady.
- Do not pull the swinging ring to the side to avoid the damage to the manipulator and the unpredictable failure.

10 General principles of maintenance

This manual is about the preventive maintenance of the manipulator. For a complete set of industrial robot system maintenance, it shall also include:

- Control cabinet maintenance-see "Control cabinet maintenance manual".
- End effector maintenance-refer to related manuals.

- Before reading the "safety rules" and safety precautions, never carry out any maintenance work, and the maintenance work can only be completed by trained technicians.
- The primary goal of preventive maintenance is to ensure maximum use of the operating system. Every scheduled and properly implemented periodic maintenance should help achieve this goal. If regular maintenance cannot achieve the goal of reducing the downtime of the device, it is unnecessary maintenance and waste.
- Robots are used to work in very demanding conditions and require minimal maintenance. However, daily inspection and regular maintenance must be carried out at given intervals.
- The time interval in the maintenance table is the recommended value. The actual time interval required for maintenance of the operator may change due to the actual working environment of the operator and other factors.
- When carrying out routine maintenance or repair, many precautions must be kept in mind to avoid introducing additional errors or hazards into the system.
- For well function equipment, do not perform more maintenance than is required for regular maintenance.
- All surfaces should be wiped clean before starting the maintenance procedure
- In order to avoid unnecessary pollution caused by dust and other sundries, the exterior of the control cabinet door and the outer cover of the operator shall be cleaned before opening.

11 Maintenance items

11.1 Daily maintenance

When operating the machine, check the following items. As shown in Table 11-1:

Table 11-1 Daily maintenance items of the manipulator

Serial number	Inspection items	Checkpoints
1	Vibration, sound, motor heating	Whether there is abnormal vibration and noise on each shaft, and whether the motor temperature is abnormally high
2	Whether there is a change in positioning accuracy	Check whether there is deviation from the last start position and whether there is deviation from the stop position
3	Action confirmation of peripheral equipment	Confirm that the actions of the operator and peripheral equipment are consistent with the instructions

11.2 First maintenance

The first 320 hours or 1 month of operation (whichever is shorter) of the operator requires inspection and maintenance of the following items. As shown in Table 11-2:

Table 11-2 First maintenance items of the manipulator

Serial number	Inspection items	Checkpoints
1	Whether the cable and cable sheath of the operator are damaged abnormally, and whether the motor connector is loose	Observe the cable moving part of the operator, check whether the cable is damaged, whether there is local bending or twisting; check whether the cable sheath is damaged; check whether the motor connector is loose (Note 1)
2	Tighten the main external bolts	Use a torque wrench to tighten the end actuator mounting bolts and the outer main bolts (Note 2)
3	Clean all parts of the operator	Clean and maintain all parts of the operator, and check whether all parts are damaged (Note 3)
4	Whether the cable of end actuator is damaged	Check whether the cable is damaged and whether the cable sheath is damaged
5	Whether the synchronous belt is worn	Check the timing belt for wear, elongation, breakage (Note 4)
6	Check whether the limit rubber block at the axes of J1, J2, J3 and J5 is damaged	Check whether the limit rubber block is loose, damaged by collision, aged, etc

Note 1:

Maintenance location

- The internal cable and cable sheath of the manipulator base (need to remove the electrical installation plate).
- Internal cable and cable sheath between the boom of the manipulator and the body of the j1 axis
- Manipulator connecting cable, grounding terminal and user cable connector.

Confirmation matters

- Check whether the line sheath is cracked and worn. If the sheath is damaged, replace it.
- Check whether the grease on the surface of the internal cable of the j1 axis and the internal cable of the boom disappears. If the grease is about to disappear, supplement it
- Check the wiring for wear and replace if the internal wire can be seen.
- Round connector: turn it by hand to see if it is loose.
- Square heavy load: confirm whether the control rod falls off.
- Ground terminal: confirm whether it is loose.

Note 2:

Fastening position

- Tighten the mounting bolts of the end actuator and the fixing bolts of the operator.
- The external connecting screws of the manipulator, especially the connecting screws between each shaft and the reducer or gearbox.
- Refer to the recommended values in the appendix of this manual for tightening torque.

Note 3:

About cleanliness

- Regularly clean the parts to be cleaned, the accumulation of dust and splashes on the plane.
- Special attention shall be paid to cleaning the rotating parts of J5 shaft, and sundries shall be removed in time.
- Confirm whether there is oil leakage from the reducer or gearbox.
- After wiping off the oil, when the oil can be seen after 1 day, there may be oil leakage.

Note 4:

About synchronous belt maintenance

- After disassembling the cover plate of the operator, observe whether the synchronous belt is worn or damaged. Please refer to *chapter12.4* of this manual for removing the cover plate.
- Observe whether there is white hair on the inner side of the synchronous belt teeth, whether there is wear on the belt side, whether the belt teeth are crushed, whether the belt body is broken, whether the belt body is extended (the preload drops), etc.

11.3 Regular maintenance

960 hours (3 months) regular maintenance

Every 960 hours or 3 months of operation (whichever is shorter), the manipulator needs to carry out the inspection and maintenance of the following items. As shown in Table 11-3:

Table 11-3 960 hours (3 months) maintenance items of the manipulator

Serial number	Inspection items	Checkpoints
1	Control cabinet vent cleaning	If there is a lot of dust on the vent of the control cabinet, please remove it
2	Cleaning of operator	Wipe off dirt and remove accumulated splashes, dust, dust, chips, etc

1920 hours (6 months) regular maintenance

Every 1920 hours or 6 months of operation (whichever is shorter), the manipulator needs to carry out the inspection and maintenance of the following items. As shown in Table 11-4:

Table 11-4 1920 hours (6 months) maintenance items of the manipulator

Serial number	Inspection items	Checkpoints
1	Whether the cable and cable sheath of the operator are damaged	Refer to *Chapter11.2* first maintenance
2	Whether the synchronous belt is worn	Check the synchronous belt for wear, elongation and fracture

3840 hours (1 year) regular maintenance

Every 3840 hours or 1 year of operation (whichever is shorter), the manipulator shall carry out the inspection and maintenance of the following items. As shown in Table 11-5.

Table 11-5 3840 hours (1 year) maintenance items of the manipulator

Serial number	Inspection items	Checkpoints
1	Whether the cable and cable sheath of the operator are damaged	*Refer to chapter Chapter11.2 first maintenance*
2	Tighten the main external bolts	*Refer to chapter Chapter11.2 first maintenance*
3	Clean all parts of the operator	*Refer to chapter Chapter11.2 first maintenance*
4	Whether the cable of end actuator is damaged	*Refer to chapter Chapter11.2 first maintenance*
5	Replace the timing belt	Refer to chapter *Chapter11.2* first maintenance
6	Check whether the limit rubber block of j1axis is damaged	Refer to chapter *Chapter11.2* first maintenance

7860 hours (2 years) regular maintenance

Every 2 years or 7860 hours of operation (whichever is shorter), the manipulator needs to carry out the inspection and maintenance of the following items. As shown in Table 11-6:

Table 11-6 7860 hours (2 years) maintenance items of the manipulator

Serial number	Inspection items	Checkpoints
1	Battery replacement	*Refer to Chapter12.3 battery replacement*

11520 hours (3 years) regular maintenance

Every 3 years or 11520 hours of operation (whichever is shorter), the manipulator needs to carry out the inspection and maintenance of the following items. As shown in Table 11-7:

Table 11-7 11520 hours (3 years) maintenance items of the manipulator

Serial number	Inspection items	Checkpoints
1	Replace the timing belt	Refer to *Chapter11.2* first maintenance

15360 hours (4 years) regular maintenance

Every 4 years or 15360 hours of operation (whichever is shorter), the manipulator needs to carry out the inspection and maintenance of the following items. As shown in Table 11-8:

Table 11-8 15360 hours (4 years) maintenance items of the manipulator

Serial number	Inspection items	Checkpoints
1	Replace the internal cable of the operator	Please consult our company to replace the cable of the operator

19200 hours (5 years) regular maintenance

Every 5 years or 19200 hours of operation (whichever is shorter), the manipulator needs to be overhauled and many parts need to be replaced. Please contact our company. As shown in Table 11-9:

Table 11-9 19200 hours (5 years) maintenance items of the manipulator

Serial number	Inspection items	Checkpoints
1	Overhaul of operator	Please consult our company

12 Project maintenance process

12.1 Manipulator cleaning

In order to ensure long-term operation of the robot, the manipulator shall be cleaned regularly every 960 hours or 3 months (whichever is shorter). The process is as follows:

Proceed as follows:

Step1. Adjust the robot to the calibration state.

Step2. To prevent danger, turn off the power, hydraulic and pneumatic sources connected to the robot.

Step3. Clean the manipulator with a vacuum cleaner or wipe with a cloth

Step4. After ensuring all safety conditions are met, carry out follow-up work of the manipulator.

Warning

- It is forbidden to use water jet on the manipulator, especially the joints, seals or cable entrances and exits.
- It is forbidden to use compressed air to clean the manipulator.
- It is forbidden to remove any protective device of the manipulator.
- It is forbidden to use solvents to clean the manipulator.

12.2 Cable maintenance

To ensure the long-term operation of the robot, check the cable of the manipulator every 1920 hours or 6 months (whichever is shorter), and the cable layout is shown in Figure 12-1:

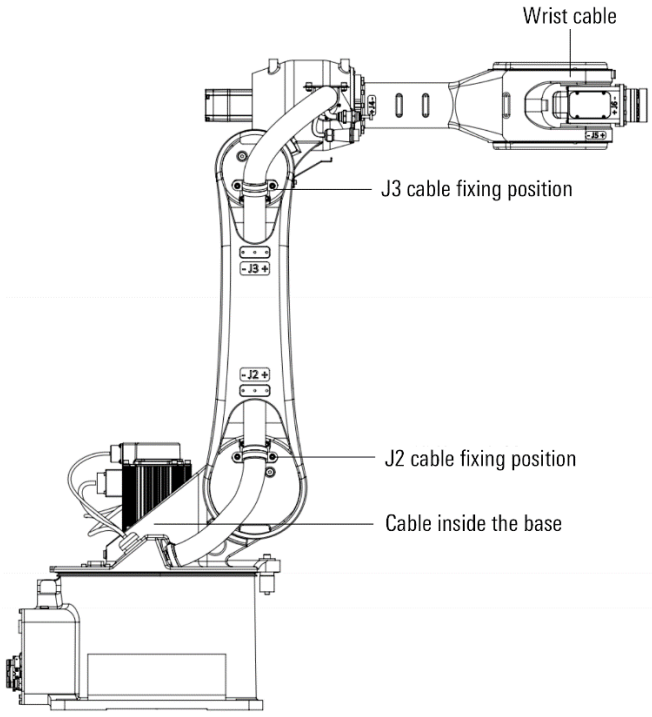


Figure 12-1 Cable layout of manipulator

External cable maintenance process

Maintenance steps:

Step1. Adjust the axes of robot from J1 to J6 to 0 °, 0 °, 90 °, - 180 °, 0 ° and 0 °.

Step2. In order to prevent danger, turn off the power, hydraulic and pneumatic sources connected to the operator

Step3. Visually inspect all external cables for wear or damage.

Step4. Check whether all cable connectors are in good condition.

Step5. Check that all brackets and tie down straps are properly secured to the manipulator.

Step6. Check whether there is abrasion or damage at the fixing place of cable and bracket.

Step7. In case of any crack, wear or damage, the company shall be contacted in time for replacement.

Internal cable of base maintenance process

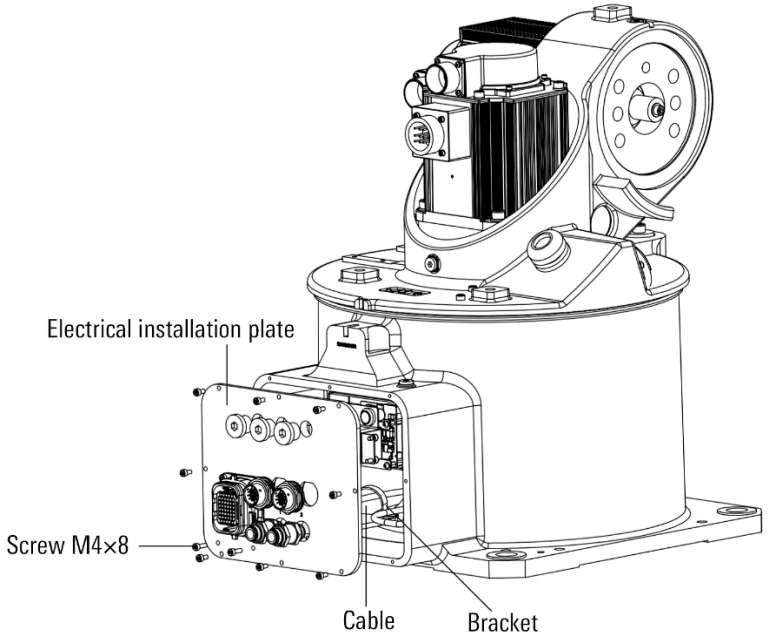


Figure 12-2 Internal cable of the small and heavy load base

Maintenance steps:

Step1. Remove the electrical installation board, as shown in Figure 12-2, and pull out the internal cable of the base.

Step2. Check whether the bracket can fix the cable on the manipulator in good condition.

Step3. Check whether there is abrasion or damage at the fixing place of cable and bracket.

Step4. Check the internal cable for wear or damage.

Step5. In case of any crack, wear or damage, the company shall be contacted in time for replacement.

Step6. Check whether the internal cable surface grease disappears.

Step7. If the lubricating grease on the cable surface disappears, it shall be supplemented in time.

Step8. install the cable into the base and keep the "U" shape.

Step9. Install the electrical installation plate, and apply sealant on the joint surface of the electrical installation plate and the base casting

Elbow internal cable maintenance process

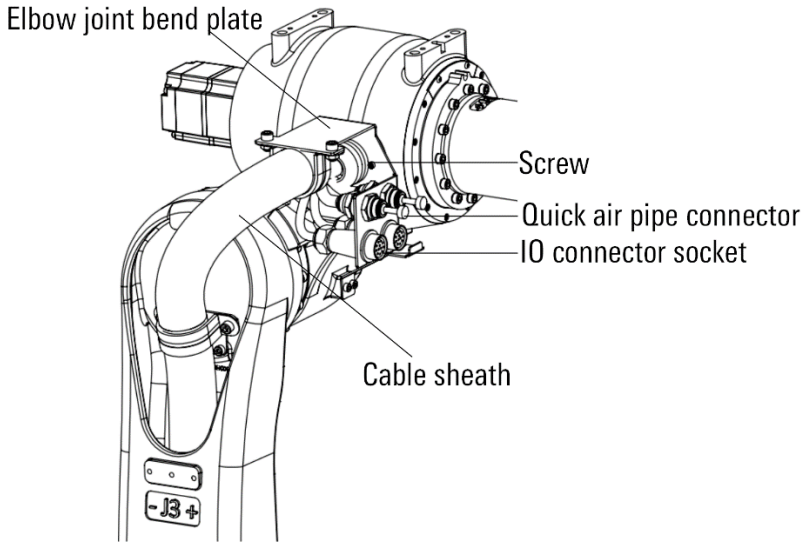


Figure 12-3 Cable inside elbow

Maintenance steps:

Step1. Disassemble the elbow joint bend plate, as shown in Figure 12-3..

Step2. Pull out the cable and check if the connection between the cable sheath and the joint bending plate is reliable.

Step3. Check whether there is abrasion or damage at the fixing place of cable and bracket.

Step4. Check the internal cable for wear or damage.

Step5. In case of any crack, wear or damage, the company shall be contacted in time for replacement

Step6. Check whether the internal cable surface grease disappears.

Step7. If the lubricating grease on the cable surface disappears, it shall be supplemented in time

Step8. Install the cable inside the elbow.

Step9. Install the cable retainer plate.

Maintenance process of wrist internal cable

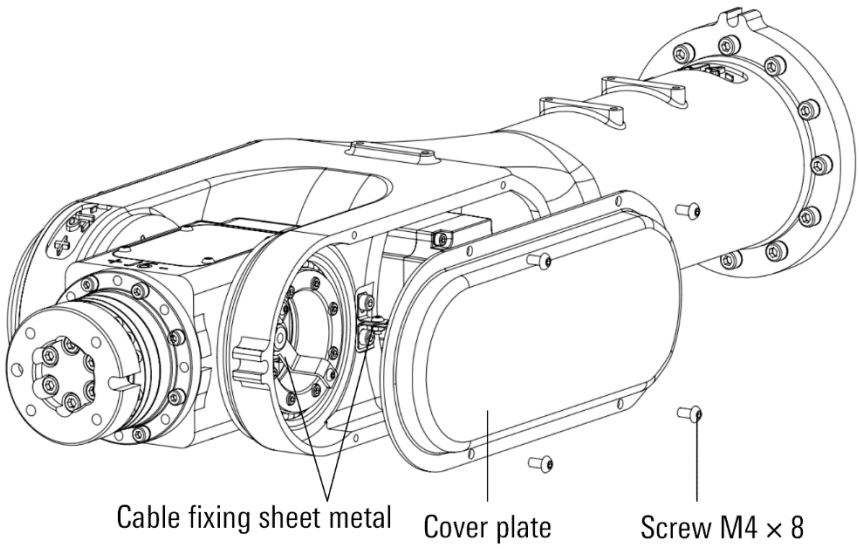


Figure 12-4 AIR12-1420 wrist internal cable

Maintenance steps:

Step1. Remove the cover plate as shown in Figure 12-4.

Step2. Check for wear or damage at the cable and cable fixing sheet metal.

Step3. Check the internal cable for wear or damage

Step4. In case of any crack, wear or damage, the company shall be contacted in time for replacement

Step5. Check whether the internal cable surface grease disappears

Step6. If the lubricating grease on the cable surface disappears, it shall be supplemented in time

Step7. Install the cover plate, and apply sealant on the joint surface of the cover plate and the boom.

Warning	Please entrust the service department of our company to replace the internal cable of the operator. The use of unqualified cable may cause the robot to fail to work normally

12.3 Battery replacement

The position data of each axis of the operator shall be saved by the encoder battery. The battery shall be replaced in time every 7860 hours or 2 years (whichever is shorter). The process is as follows.

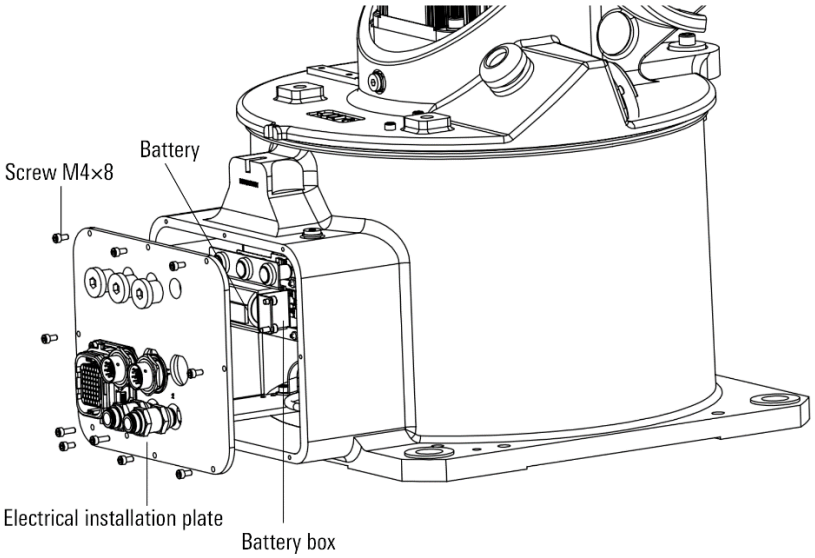


Figure 12-5 Electrical installation panel of small and heavy load disassembly manipulator

Replacement steps:

Step1. Adjust the robot to the calibration state.

Step2. To prevent danger, turn off the power, hydraulic and pneumatic sources connected to the robot.

Step3. Remove the electrical installation board of the operator and remove the battery box, as shown in Figure 12-5.

Step4. Remove the old battery from the battery box, install the new battery into the battery box, and pay attention to the positive and negative polarity of the battery.

Step5. Reconnect the battery cable.

Step6. Install the battery box.

Step7. Install the electrical installation plate, and apply sealant on the joint surface of the electrical installation plate and the base casting.

Step8. After all safety conditions are met, calibrate and test the manipulator.

12.4 Changing grease

The internal grease shall be replaced every 11520 hours or 3 years (whichever is shorter) from the operation of the machine's J1 axis to J6 axis reducer.

Refer to Table 12-1 for model and quantity of lubricating grease:

Table 12-1 Type and quantity of lubricating grease of the AIR12-1420

Model of operator	Replacement of grease	Grease content	Grease model
AIR12-1420	J1 axis reducer	286g	VIGOGREASE RE0
	J2 axis reducer	333g	
	J3 axis reducer	166g	

When changing the lubricating grease, please refer to Table 12-2 for the manipulator attitude:

Table 12-2 Manipulator 's attitude of changing lubricating grease

Replacement of grease	J1	J2	J3	J4	J5	J6
J1 axis reducer	180°	0°	90°	Arbitrary angle	Arbitrary angle	Arbitrary angle
J2 axis reducer	0°	0°	90°	Arbitrary angle	Arbitrary angle	Arbitrary angle
J3 axis reducer	0°	45°	-45°	Arbitrary angle	Arbitrary angle	Arbitrary angle

Warning

- The oil temperature of reducer may be higher than 90℃ and it shall be replaced after cooling
- Wear gloves to prevent allergic reactions
- Carefully and slowly open the drain port to prevent oil splashing

J1 axis reducer replacement grease process

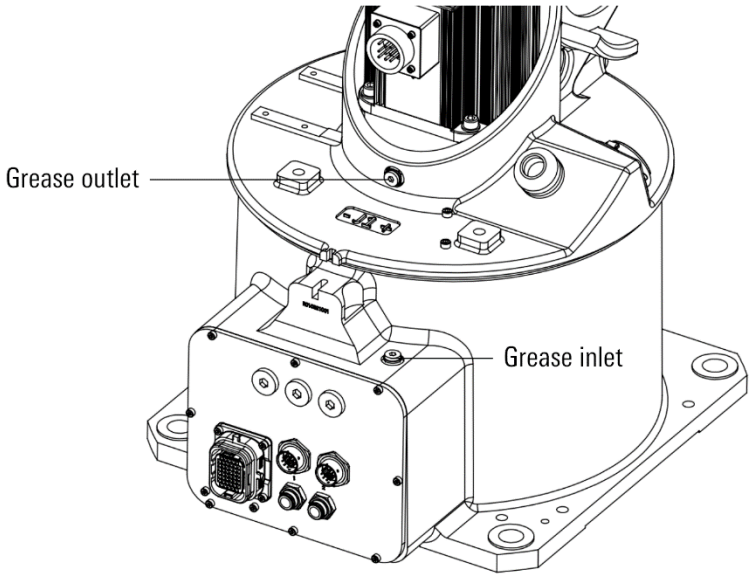


Figure 12-6 Replace the lubricating grease of the reducer of the J1 axis

Replacement steps:

Step1. Operate the operator to the attitude shown in Table 12-2.

Step2. To prevent danger, turn off the power, hydraulic and pneumatic sources connected to the robot.

Step3. Place the waste oil collection tank near the grease discharge port.

Step4. Remove the M10x1 plug of grease discharge port, as shown in Figure 12-6.

Step5. Install the grease drain pipe to ensure the waste oil flows into the oil sump.

Step6. Remove the grease injection plug, install the grease injection nozzle, and use the manual grease injection gun to inject grease until the new grease is discharged from the grease discharge port.

Step7. Release the internal grease pressure of the reducer as shown in Table 12-3.

Step8. Weigh the amount of grease discharged and the amount of grease injected, both of which shall be equal; if the amount of grease discharged is less than the amount of grease injected, inflate the grease injection port to discharge the excess amount; if the amount of grease discharged is greater than the amount of grease injected; inject the amount of grease from the grease injection port in shortage.

Step9. Remove the grease injection nozzle, install the M10x1 plug at the grease discharge port and grease injection port, and apply the sealing tape/sealant.

Caution	When the grease is injected from the grease injection port to the inside of the operator, the grease injection speed of the manual pump is less than 8g/s, and the grease injection pressure is less than 0.3MPa. In order to ensure that the old oil in the reducer can be removed smoothly, after filling for a period of time, take a rest for a while, and continue to fill when there is no old grease discharged from the oil outlet. When the oil filling speed is too fast, the instantaneous pressure inside the reducer becomes higher, which may cause the oil seal of the motor to be damaged and the grease will enter the motor.

J2 axis reducer replacement grease process

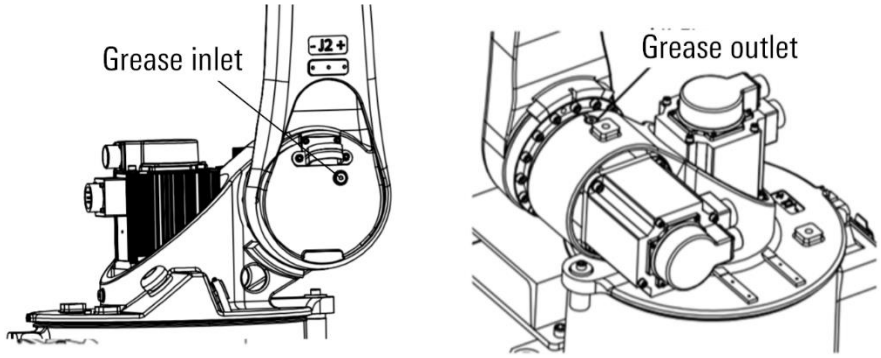


Figure 12-7 AIR12-1420 replacing the J2 axis reducer grease

Replacement steps:

Step1. Operate the operator to the attitude shown in Table 12-2.

Step2. To prevent danger, turn off the power, hydraulic and pneumatic sources connected to the robot.

Step3. Place the waste oil collection tank near the grease discharge port.

Step4. Remove the M10x1 plug of grease discharge port, as shown in Figure 12-7.

Step5. Install the grease drain pipe to ensure the waste oil flows into the oil sump.

Step6. Remove the M10x1 plug of grease injection port, install the grease injection nozzle, and use the manual grease injection gun to inject grease until the new grease is discharged from the grease discharge port.

Step7. Release the internal grease pressure of the reducer as shown in Table 12-3.

Step8. Weigh the amount of grease discharged and the amount of grease injected, both of which shall be equal; if the amount of grease discharged is less than the amount of grease injected, inflate the grease injection port to discharge the excess amount; if the amount of grease discharged is greater than the amount of grease injected; inject the amount of grease from the grease discharge port to be insufficient.

Step9. Remove the grease injection nozzle, install M10x1 plug at the grease discharge port and grease injection port, and apply sealing tape/sealant.

> Caution
>
> When the grease is injected from the grease injection port to the inside of the operator, the grease injection speed of the manual pump is less than 8g/s, and the grease injection pressure is less than 0.3MPa. In order to ensure that the old oil in the reducer can be removed smoothly, after filling for a period of time, take a rest for a while, and continue to fill when there is no old grease discharged from the oil outlet. When the oil filling speed is too fast, the instantaneous pressure inside the reducer becomes higher, which may cause the oil seal of the motor to be damaged and the grease will enter the motor.

J3 axis reducer replacement grease process

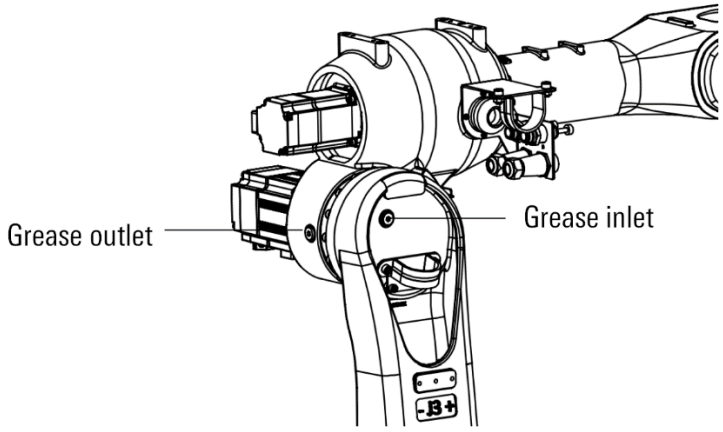


Figure 12-8 AIR12-1420 replacing the J3 axis reducer grease

Replacement steps:

Step1. Operate the operator to the attitude shown in Table 12-2.

Step2. To prevent danger, turn off the power, hydraulic and pneumatic sources connected to the robot.

Step3. Place the waste oil collection tank near the grease discharge port.

Step4. Remove the M10x1 plug of grease discharge port, as shown in Figure 12-8.

Step5. Install the grease drain pipe to ensure the waste oil flows into the oil sump.

Step6. Remove the M10x1 plug of grease injection port, install the grease injection nozzle, and use the manual grease injection gun to inject grease until the new grease is discharged from the grease discharge port.

Step7. Release the internal grease pressure of the reducer as shown in Table 12-3.

Step8. Weigh the amount of grease discharged and the amount of grease injected, both of which shall be equal; if the amount of grease discharged is less than the amount of grease injected, inflate the grease injection port to discharge the excess amount; if the amount of grease discharged is greater than the amount of grease injected; inject the amount of grease from the grease discharge port to be insufficient.

Step9. Remove the grease injection nozzle, install M10x1 plug at the grease discharge port and grease injection port, and apply sealing tape/sealant.

Caution

When the grease is injected from the grease injection port to the inside of the operator, the grease injection speed of the manual pump is less than 8g/s, and the grease injection pressure is less than 0.3MPa. In order to ensure that the old oil in the reducer can be removed smoothly, after filling for a period of time, take a rest for a while, and continue to fill when there is no old grease discharged from the oil outlet. When the oil filling speed is too fast, the instantaneous pressure inside the reducer becomes higher, which may cause the oil seal of the motor to be damaged and the grease will enter the motor.

Release the internal grease pressure of the reducer

When releasing the internal grease pressure of the reducer, please install a recovery device at the grease discharge port to avoid splashing of the outflow grease and polluting the environment.

Table 12-3 Release the internal pressure of reducer and gearbox

Replacement of grease	Action angle	Action time	premise
J1 axis reducer	>90°	10 minutes	The grease injection port is equipped with plug or oil injection nozzle, and the grease discharge port is not equipped with sealing screw
J2 axis reducer	>90°	10 minutes	
J3 axis reducer	>90°	10 minutes	

Caution

During the wrong grease supply operation, the pressure in the reducer or gearbox may rise sharply, and the internal parts such as the sealing ring may be damaged, resulting in oil leakage or poor operation. The following precautions must be observed

- Before supplying grease, always remove the sealing screw of the grease outlet.
- Use manual pump to slowly supply grease.
- Always use the specified grease.
- After the grease supply, release the internal pressure according to the steps in Table 12-3 and then install the sealing screw.
- Thoroughly wipe off the grease stuck on the floor and the operator to avoid slipping

12.5 Replace synchronous belt

The J5 axis synchronous belt needs to be replaced every 11520 hours or 3 years (whichever is shorter).

Refer to Table 12-4 for model of synchronous belt:

Table 12-4 Model of synchronous belt of manipulator

Model of manipulator	Synchronous belt position	Model of synchronous belt
AIR12-1420	J5 axis inside the forearm	GT3, 425-5MGT-9

When replacing the synchronous belt, please refer to Table 12-5 for the attitude of the manipulator:

Table 12-5 Attitude of manipulator replacing synchronous belt

J1	J2	J3	J4	J5	J6
Arbitrary angle	0°	90°	0°	90°	Arbitrary angle

Replacement process of J5 axis synchronous belt

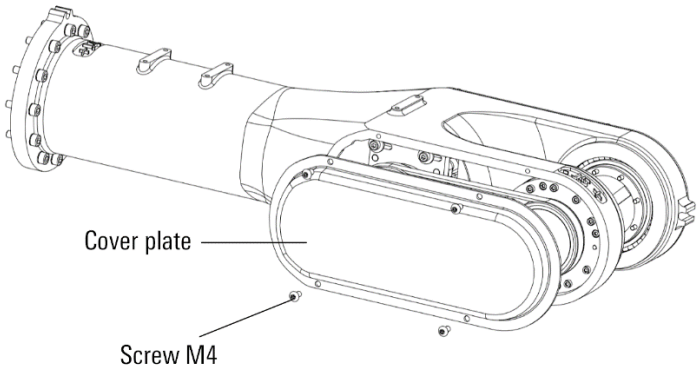


Figure 12-9 Removing the cover plate

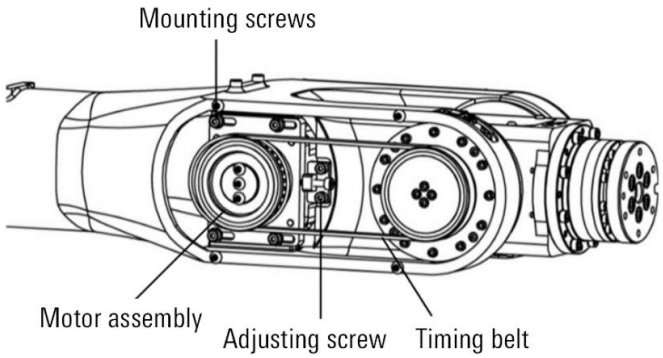


Figure 12-10 Removing the timing belt

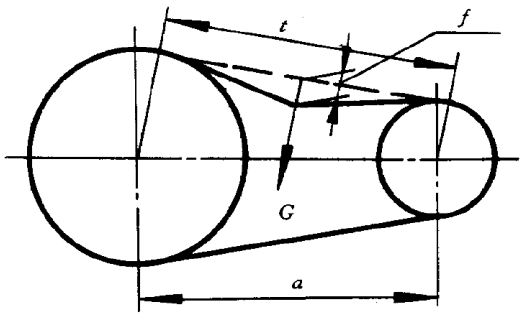


Figure 12-11 Installation deflection of synchronous belt

Replacement steps:

Step1. Operate the manipulator to the attitude shown in Table 12-5.

Step2. Turn off the power to the control.

Step3. Remove the manipulator cover plate and four M4 screws, as shown in Figure 12-9.

Step4. Loosen the timing belt adjusting screw

Step5. Remove four M4 screws from the motor base, as shown in Figure 12-10.

Step6. Move the motor pulley assembly, remove the old synchronous belt and install the new one

Step7. Install the motor base screw M4 preliminarily

Step8. The Allen wrench is equipped with adjusting screw to adjust the synchronous belt to the appropriate tension; the frequency of synchronous belt is 125.6Hz~131.6Hz, which can also be measured by pressure method, with pressure g = 2.3N and deformation f = 2.0mm

Step9. Install the motor base screw M4 with the specified torque

Step10. Install the cover plate of the manipulator and apply sealant to the joint

Step11. Calibrate J5 axis of the manipulator.

After replacing the synchronous belt, the J5 axis of the operator shall be calibrated. See *Chapter8* of this manual for details.

13 Common faults and handling

The failure of the operator is sometimes caused by several different reasons. It is difficult to find out the causes thoroughly. If the error handling method is adopted, it may lead to further deterioration of the failure. Therefore, it is very important to analyze the failure situation in detail and find out the real cause.

Vibration or abnormal noise occurs

Possible faults and causes of the manipulator are shown in Table 13-1. If you are uncertain about the cause or how to deal with it, please contact our company.

Table 13-1 Possible faults and causes of the manipulator

Fault	Fault classification	Possible cause	Solution
Vibration Abnormal noise	■ When the manipulator operates, the manipulator base is floated from the workshop pedestal ■ There is a gap between the base and the pedestal ■ The connection screws between the base and the pedestal are loose	Fixing of the base: ■ It may be because the manipulator base is not firmly fixed on the workshop pedestal ■ It may be because the base is floated from the workshop pedestal and the impact vibration is generated when the manipulator moves due to loose screws, insufficient flatness of the base and inclusion of foreign objects	■ When the screws are loose, tighten them at an appropriate torque with a torque wrench ■ Trim the flatness of the base to meet the tolerance requirements ■ Check whether there is any foreign matter trapped, and if yes, remove it ■ Please contact the company
	The workshop pedestal vibrates when the manipulator moves	Workshop pedestal: ■ It may be because the workshop pedestal is not completely fixed onto the workshop foundation, and the workshop pedestal generates vibration during operation and movement ■ It may be because the workshop pedestal has poor rigidity and is involved with deformation due to reaction forces and moments generated when the manipulator moves	■ Fix the workshop pedestal completely through corresponding methods ■ Machine the workshop pedestal to increase its rigidity ■ For the workshop pedestal that is difficult to machine, the vibration can be reduced by changing the movement program ■ Please contact the company
Vibration Abnormal noise	■ Vibration is generated in a specific posture during movement ■ No vibration is found after the operation speed is slowed down ■ Vibration is obvious during acceleration and deceleration ■ Multiple axes are involved with vibration simultaneously	■ It may be because the load of the manipulator exceeds the allowable value ■ It may be because the operation program is strict for the manipulator ■ It may be because the acceleration is inappropriate	■ Check whether the load of the manipulator exceeds the allowable value, reduce the load or change the operation program ■ The vibration of specific parts can be reduced by reducing the speed, reducing the acceleration, and changing the operation program.

Fault	Fault classification	Possible cause	Solution
	■ Vibration occurs when the manipulator collides or runs under heavy-duty for a long time ■ vibration occurs when the grease has not been changed for a long time	■ It may be because the mechanical transmission system suffers excessive external force due to collision or heavy-duty, which causes damage to the gear or rolling surfaces of gears, bearings and reducers, or peeling off due to fatigue ■ It may be because any foreign matter is trapped in the gear, bearing and reducer, which causes damage to the gear or rolling surface of the gear, bearing and reducer ■ It may be because the manipulator is used for a long time without changing the grease, which causes the gear or rolling surface of gear, bearing and reducer to peel off due to fatigue ■ The above reasons can cause periodic vibration or abnormal noise	■ Keep the manipulator moving in a single axis and determine the axis that generates vibration or noise ■ If you want to replace gear, bearing and reducer parts, please contact the company ■ Avoid operating the manipulator under heavy-duty ■ If you want to change the grease, please contact the company ■ Please contact the company
Vibration Abnormal noise	Causes that cannot be determined by the mechanical part	■ The circuit in the control device fails, the instruction is not correctly transmitted to the motor, or the motor information is not correctly transmitted to the control device, which causes the manipulator to vibrate. ■ The pulse encoder fails, and the position of the motor is not correctly transmitted to the control device, which causes the manipulator to vibrate ■ The main body of the motor fails, and the motor loses its original performance, which causes the manipulator to vibrate ■ The b motor cable inside the manipulator is damaged or broken, and the instruction value is not correctly transmitted to the motor and control system, which causes the manipulator to vibrate. ■ The voltage drops and the specified voltage cannot be guaranteed, which causes the manipulator to vibrate ■ The input of incorrect motion control parameters causes the manipulator to vibrate	■ For faults of the control device, please refer to the operation instructions for control device ■ Replace the motor on the vibration axis and check whether there is any vibration ■ Check whether the cables on the manipulator body, the cables between the manipulator body and the control cabinet and the cables inside the control device are damaged, and if yes, replace them. ■ Check whether the cable connector is in good contact, and if not, retighten it or take measures to ensure good contact. ■ Check whether the operation control parameters are correct, and if not, re-enter the correct parameters. ■ Please contact the company

Fault	Fault classification	Possible cause	Solution
	The operation status of the machinery near the manipulator is closely related to the vibration of the robot	■ Electrical noise from machinery near the manipulator ■ When the ground wire is not connected properly, electrical noise will be mixed into the ground wire, which causes the manipulator's vibration due to interference of instruction ■ If the ground wire is connected in an unsuitable place, it may cause unstable grounding, which causes the manipulator to vibrate due to electrical noise interference.	■ Connect the ground wire properly to avoid electrical noise from being mixed into the manipulator ■ Please contact the company
Vibration Abnormal noise	■ Abnormal noise occurs after changing grease ■ Abnormal noise occurs when the robot is put into operation after long-time shutdown ■ Abnormal noise occurs during the low speed operation	The manipulator has abnormal noise at low operation speed immediately after replacement or upon restart after long-term shutdown	Observe the operation of the manipulator for 1-2 days. Usually, the abnormal noise will disappear

Shaking of manipulator

The reasons for the shaking of the manipulator and the countermeasures are shown in Table 13-2. If you are not sure of the cause or how to deal with it, please contact our company.

Table 13-2 Causes of shaking of the manipulator and treatment measures

Fault	Fault classification	Possible cause	Solution
Shaking of manipulator	■ After cutting off the power of the manipulator, shake some parts of the manipulator by hand ■ There is a gap in the joint surfaces of the manipulator	■ The manipulator bolts are loose ■ It may be because some connection bolts on the manipulator are loose due to heavy-duty or collision, which causes the shaking	Check whether the bolts in the following parts of the axes are loose, and if yes, tighten them at an appropriate torque with a torque wrench. ■ Motor fixing bolt ■ Reducer housing fixing bolt ■ Reducer output shaft fixing bolt ■ Base fixing bolt ■ Inter-arm fixing bolt ■ Housing fixing bolt ■ End actuator fixing bolt

Fault	Fault classification	Possible cause	Solution
	Cut off the power supply of the manipulator, and after checking that the screws are tightened, shake the whole head of the manipulator by hand.	It may be because the internal gear of the manipulator is worn or damaged due to heavy-duty, collision, having a wide backlash	If you want to replace the internal gear, please contact the company

Motor overheating

The reasons and treatment measures of the motor overheating are shown in Table 13-3. If you are not sure of the cause or how to deal with it, please contact our company.

Table 13-3 Causes of motor overheating and treatment measures

Fault	Fault classification	Possible cause	Solution
Motor overheating	■ The temperature in the manipulator installation environment rises, and the motor overheats ■ The motor overheats after a cover is installed on it ■ The motor overheats after changing the operation program and load conditions of the manipulator	Ambient temperature: After the ambient temperature rises or the motor cover is installed, the heat dissipation of the motor deteriorates, which causes the motor to overheat Load action: It may be because the motor current value exceed the rated value due to the load and operation program	■ Reduce the ambient temperature, which can effectively prevent the motor from being overheated ■ Improve the ventilation conditions around the motor, and that is, the heat dissipation of the motor, which can effectively prevent the motor from being overheated ■ When there is a heat source around the motor, a radiation shielding plate can be provided to effectively prevent the motor from being overheated ■ Through slowing down the operation program and reducing the load conditions, the average motor current value will be decreased, preventing the motor from being overheated ■ Please contact the company
	The motor overheats after changing the operation control parameters of the manipulator	Control parameters: If the input parameters are inappropriate, the acceleration and deceleration of the robot will be inappropriate, which causes the increase in the average motor current and motor overheating.	■ Input the appropriate parameters according to the relevant instructions ■ Please contact the company

Fault	Fault classification	Possible cause	Solution
	The motor overheats in the conditions other than above	Mechanical fault of manipulator: It may be because the mechanical system of the manipulator fails, which causes the motor to overheat due to high load Fault of motor: ■ It may be because the motor brake fails and causes the motor to always operate with the brake applied, which causes the motor to overheat due to high load ■ It may be because the main body of the motor fails and the motor loses its original performance, which causes excessive current to flow through the motor, which causes the motor to overheat	■ Please refer to vibration, abnormal noise and looseness items to eliminate the mechanical fault. ■ Please check whether the brake is released when the motor is powered on. ■ When the motor overheating is eliminated after replacing the motor, it can be confirmed to be abnormal ■ Please contact the company

Grease leakage

The reasons for grease leakage and the treatment measures are shown in Table 13-4. If you are not sure of the cause or how to deal with it, please contact our company.

Table 13-4 Causes of grease leakage and treatment measures

Fault	Fault classification	Possible cause	Solution
Grease leakage	Grease leaks out of the mechanical parts	Poor seal: ■ It may be because the casting is cracked due to excessive external force caused by the collision, which causes grease leakage ■ It may be because O-rings are damaged during disassembly and reassembly, which causes grease leakage ■ It may be because the dust enters and the oil seal is scratched, which causes grease leakage ■ It may be because there is poor seal between the cover and the casting, which causes grease leakage	■ In case of cracks in castings, sealant can be used to block the grease as an emergency measure. However, considering that the cracks may be further expanded, it is necessary to replace the parts as soon as possible. ■ Please contact the company

Drop of manipulator axis

The reasons and countermeasures for the falling of the operating crankshaft are shown in Table 13-5. If you are not sure of the cause or how to deal with it, please contact our company.

Table 13-5 Reasons for the falling of the manipulator shaft and its treatment

Fault	Fault classification	Possible cause	Solution
Drop of manipulator axis	■ The brake fails completely and the axis drops quickly ■ The axis slowly drops after the brake is locked	■ It may be because the brake drive relay is damaged, and the brake is always in the energized status, having no braking effect. ■ It may be because the braking effect is reduced due to wear to the brake and damage to the brake body ■ It may be because the lubricating oil and grease enter the motor, which causes the brake slipping	■ Check whether the brake drive relay is damaged, and if yes, replace it ■ If the brake is worn, the brake body is damaged, or the grease has entered the motor, replace it. ■ Please contact the company

Position offset

The reasons for the position shift and the countermeasures are shown in Table 13-6. If you are not sure of the cause or how to deal with it, please contact our company.

Table 13-6 Causes of position shift and treatment measures

Fault	Fault classification	Possible cause	Solution
Position offset	■ The manipulator motion deviates from the teaching position ■ The manipulator's repositioning accuracy is greater than the allowable value	Mechanical fault: ■ If the repositioning accuracy is unstable, it may be caused by the failure of the mechanical system, loose screws, etc. ■ After certain deviation, the repositioning accuracy is stable. It may be because the base surface and the joint surface between the castings of the axes and the reducer slide due to excessive loads such as collision. ■ It may be because the motor encoder is faulty	■ When the repositioning accuracy is unstable, please refer to the vibration, abnormal noise and shaking items to eliminate the mechanical fault ■ When the repositioning accuracy is stable, please modify the teaching program. If the collision no longer occurs, there will be no position offset. ■ If the motor encoder is faulty, please replace the motor or encoder ■ Please contact the company
	The position offset is only involved with specific peripheral equipment	Position offset of peripheral equipment: It may be because the peripheral equipment is subjected to external forces, which causes it to be offset from the manipulator.	■ Please change the position of the peripheral equipment ■ Please modify the teaching program ■ Please contact the company

Fault	Fault classification	Possible cause	Solution
	The position offset occurs after changing the parameters	Parameters: It may be because the origin of the manipulator is lost due to modification of the calibration data	■ Re-enter the previously correct calibration data ■ In case of uncertain calibration data, please recalibrate the manipulator ■ Please contact the company

14 Storage condition

14.1 Environmental conditions for long-term storage of the manipulator

Table 14-1 Environmental conditions for long-term storage of the manipulator

Parameter	Numerical value
Minimum ambient temperature	-25℃
Maximum ambient temperature	55℃
Maximum ambient temperature (storage time less than 24h)	70℃
Maximum ambient humidity	Less than 95% at constant temperature, no condensation
Maximum vibration condition	Frequency 22Hz, amplitude 0.15mm

14.2 Precautions for storage of manipulator

In addition to meeting the requirements of *chapter1.4* of this manual, the manipulator shall also pay attention to the following items during long-term storage

- Before long-term storage, the operator's posture shall be in the handling posture and placed on the horizontal plane. See *Chapter4* of this manual for details.
- When the manipulator is not in use for a long time, cut off all the power supply, unplug the heavy-duty connector on the body, and cover the protective cover of the heavy-duty connector
- The paper or wooden packing box and other external protective covers shall be used for external protection of the manipulator to avoid long-term exposure to light or contact with water, oil, corrosive liquid, etc
- Clean the surface of the operator regularly, such as dedusting and decontamination. The specific cleaning cycle depends on the storage environment of the manipulator
- When the storage period is over and the manipulator is put into use again, the manipulator must be checked according to *Chapter3.1* of this manual

Appendix A Periodic maintenance form of manipulator

Appendix A periodic maintenance form of manipulator (Note: ○ indicates that maintenance is required.)

Maintenance item		Maintenance time	First maintenance 320H	3 months 960H	6 months 1920H	9 months 2880H	1 year 3840h	15 months 4800h	18 months 5760h	21 months 6720h	2 years 7680h	27 months 8640h	30 months 9600h	33 months 10560h	3 years 11520h	39 months 12480h	42 months 13440h	45 months 14400h	4 years 15360h	51 months 16320h	54 months 17280h	57 months 18240h	5 years 19200h
1	Clean the manipulator	0.5h	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2	Clean the control cabinet vent	0.1h	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
3	Check whether the timing belt is worn	0.5h	○		○		○		○		○		○		○		○		○		○		○
4	Check whether the manipulator cable is damaged	3h	○		○		○		○		○		○		○		○		○		○		○
5	Whether the manipulator wire tube is damaged	2h	○		○		○		○		○		○		○		○		○		○		○
6	Check whether the connecting cables between the teach pendant, control cabinet and manipulator are	0.2h	○				○				○				○				○				○

Maintenance item		Maintenance time	First maintenance 320H	3 months 960H	6 months 1920H	9 months 2880H	1 year 3840h	15 months 4800h	18 months 5760h	21 months 6720h	2 years 7680h	27 months 8640h	30 months 9600h	33 months 10560h	3 years 11520h	39 months 12480h	42 months 13440h	45 months 14400h	4 years 15360h	51 months 16320h	54 months 17280h	57 months 18240h	5 years 19200h
	damaged																						
7	Check whether the connectors such as motors are loose	0.2h	○				○				○				○				○				○
8	Tighten the end actuator screws	0.2h	○				○				○				○				○				○
9	Tighten main external screws	1h	○				○				○				○				○				○
10	Check whether the end actuator cable is damaged	0.2h	○				○				○				○				○				○
11	Check whether the limit block is damaged	0.1h	○				○				○				○				○				○
12	Replace the timing belt	1h					○				○				○				○				○
13	Replace the battery	0.5h									○								○				
14	Change the grease	8h													○				○				
15	Replace the cables inside the manipulator	8h																	○				
16	Major repair of																						○

Maintenance item	Maintenance time	First maintenance 320H	3 months 960H	6 months 1920H	9 months 2880H	1 year 3840h	15 months 4800h	18 months 5760h	21 months 6720h	2 years 7680h	27 months 8640h	30 months 9600h	33 months 10560h	3 years 11520h	39 months 12480h	42 months 13440h	45 months 14400h	4 years 15360h	51 months 16320h	54 months 17280h	57 months 18240h	5 years 19200h
manipulator																						
Note: ○indicates that maintenance is required																						

Appendix B Table of screw strength and tightening torque (Nm)

Appendix B1 Strength and tightening torque of screws(Nm)

Performance grade / Thread specification	Level 8.8	Level 10.9	Level 12.9
M3	1.2	1.6	2.0
M4	2.8	3.7	4.4
M5	5.6	7.5	9
M6	9.5	12.5	15
M8	23	31	36
M10	45	60	70
M12	78	104	125
M14	113	165	195
M16	195	250	305
M20	370	500	600

Appendix B2 Stainless steel screw strength and screw tightening torque table (Nm)

Thread size	Stainless steel A4-80	Stainless steel A2-70 and A4-70	Stainless steel A2-50
M3	1.0	0.8	0.4
M4	2.4	1.9	0.9
M5	4.8	3.8	1.9
M6	8.0	6.4	3.1
M8	19.5	15.5	7.5
M10	38.5	30.5	15.0
M12	66.0	52.0	25.5
M14	106.0	84.0	41.0
M16	165.0	130.0	64.0
M20	320.0	253.0	125.0
M24	557.0	441.0	217.0
M30	1107.0	876.0	-

Prompt

- All screws must be tightened with proper torque
- In addition to the torque specified in the text, the corresponding tightening torque shall be selected according to the screw performance level
- Remove foreign matters from screws and threaded holes

- Torque applies to lightly lubricated screws
- Screws shall be tightened evenly and symmetrically
- According to the installation requirements of the reducer and other moving parts, apply thread glue to the engagement part of some screws.

PEITIAN ROBOTICS

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